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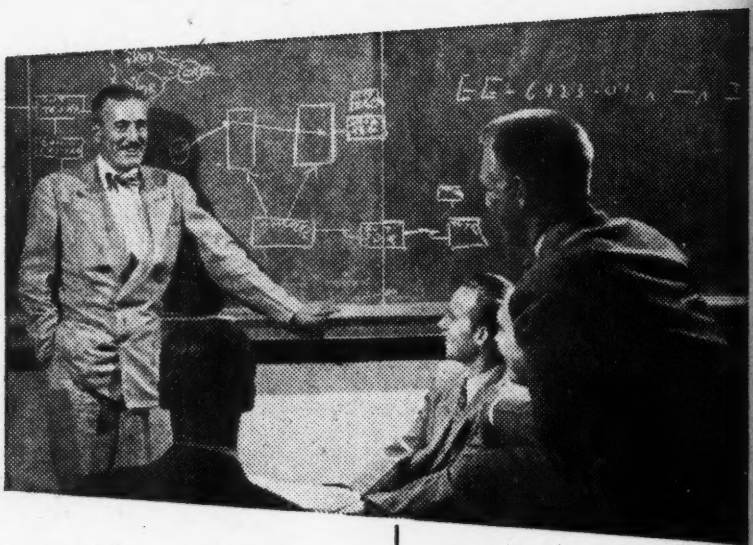
The American Society for Engineering Education



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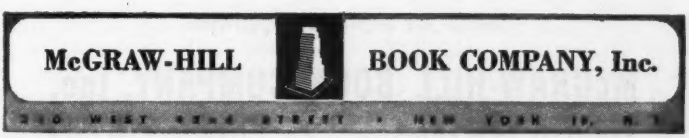

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Dartmouth College—June 23-27, 1952.

By JANE A. BENNETT

Assistant, Office of the News Service, Dartmouth College

Crowned by Mt. Washington, highest point in the East, and embellished by cool forests, rolling hills, scenic lakes and rivers, and a tiny patch of seacoast, New Hampshire in the summer is as good a place to live and play in as it is to look at. The topography, the weather and the people have banded together to make the state one of the most versatile recreation areas in the country. The artist and the mountain climber, the fisherman and the tourist will all find what they seek in the Granite State.

Besides the man-made recreational facilities and such natural attractions as lakes and mountains, New Hampshire has an ideal summer vacation climate, pleasantly warm days and cool nights. This variability in temperature is healthful as well as enjoyable.

Parks, maintained in all parts of the state by the Forestry and Recreation Department, offer camp sites, hiking trails, fishing, swimming, and picnicking areas; private organizations such as the Appalachian Mountain Club and the Dartmouth Outing Club help the U. S. Forestry Service in caring for the miles of tramping trails which cross and recross the state; Yankee hostelries invite the traveler at all seasons of the year, and Yankee ingenuity provides him with things to see and do.

The northernmost part of the state is noted for its fish-laden Connecticut Lakes where land-locked salmon, lake trout and brook trout tempt the anglers. The Connecticut, which forms the greater part of New Hampshire's western boundary, has its origin in these northern lakes.

Another favorite fishing spot, not far from Dartmouth College, is Lake Sunapee, famed for its *aureolus* or golden trout which is exclusively a New Hampshire fish. Hundreds of streams and ponds provide brook and rainbow trout, bass, pickerel, and land-locked salmon, and new fishing areas are constantly being created by reclamation and stocking.

Moose Brook State Park, north of the Presidential Range, is well located for the trout fisherman because the Ammonoosuc and Moose Rivers and several of their tributaries run through the area. For the salt-water fisherman New Hampshire offers the waters off New Castle and the Isles of Shoals where bluefin tuna may be speared.

Since Pinkham Notch is the headquarters of the Appalachian Mountain Club, hikers flock to the Granite State. A system of shelters is maintained and the trails are kept in good condition in the White Mountain National Forest and the numerous state parks.

Wellington Park, not far from Hanover, Monadnock Park, in the southern part of the state, and Moose Brook and Mt. Prospect Parks in the White Mountain area are networked with hiking trails, some of which double for skiing

during the winter months. Mt. Sunapee State Park and Belknap Recreation Area near Guilford operate as both summer and winter parks, running chair lifts the year round for sightseeing and skiing and providing good swimming and playing facilities.

New Hampshire's parks are a great credit to the state. All provide attractive picnicking areas and are well maintained. Most parks have camping sections and, wherever possible, bathing places. Rhododendron State Reservation in the southern part of the state is a naturalist's playground in July when the shrub which gives the park its name is in bloom. Weekly square dances and the annual craftsmen's fair are held in the Belknap Recreation Area. Mt. Sunapee Park provides such summer attractions as periodic lobster feasts and clam bakes atop the mountain, Blanket Pops concerts, and the annual Guides Show, a field day for woodsmen.

Many recreational facilities are offered by private concerns. Dartmouth's Mount Moosilauke, near Warren, lures climbers with its pleasant climbing trails and the comfortably rustic Ravine Lodge at the foot. The Maine-to-Georgia Appalachian Trail runs through the reservation. Franconia Notch, Tuckerman Ravine, North Conway and other New Hampshire spots that are by-words to the Eastern skiing fraternity have their summer appeal as well. The Mt. Cranmore skimobile at North Conway and the aerial passenger tramway at Cannon Mountain are busy all year round taking visitors to mountain peaks from which spectacular views are to be had. The tramway, opened in 1938, is the only one of its kind in North America. Its glass-enclosed cars, hanging from heavy cables, carry 27 passengers at a time from the valley station to an elevation of over 4000 feet.

The Presidential Range from Pinkham Notch

New Hampshire's recreational facilities are not all for the outdoorsman; the vacationist who likes to relax or take sightseeing tours is welcomed by the state's hostelries which range in style from the sumptuous Mount Washington Hotel at Bretton Woods to the simplicity of the cabin courts. Although many vacation resorts provide recreational facilities, a series of day trips from almost any place in the state will yield a variety of sights and activities.

Visitors to the White Mountain National Park must crane their necks to gaze up at the "Old Man of the Mountains" high on Profile Mountain. This is only part of a 6000-acre wonderland known as Franconia Notch. In the park cutting precipitously into the rock at the foot of Mt. Liberty is the Flume, a geologic chasm almost 700 feet long. A drive through Franconia Notch is an easy trip from the vicinity of Hanover.

Mt. Washington with its cog railway is an attraction for all New Hampshire's visitors. The highest peak east of the Rockies and north of the Carolinas has a weather all its own; passengers on the famous railway riding up in the sunlight may arrive at the summit in a cloud bank or may be treated to a view of several states. There are a hotel, an Air Force icing research station, and a weather observatory on the mountain top.

The Connecticut River Valley Near Dartmouth College, Hanover, N. H.

The cog railway, reputedly one of the shortest, safest, and most expensive railroads to operate in the world, was invented by Sylvester Marsh and the first ascent was made in 1869. Marsh allowed Swiss engineers to copy his railway for the Alps. Both the automobile road and the railway are open until the middle of October.

At the Lost River Reservation, west of Franconia Notch, there is a tour through the scenic gorge filled with phenomena of nature, and Kinsman and Crawford Notches are targets for many visitors' cameras. As an aid to travelers the state of New Hampshire has carefully labeled its views by means of roadside signs.

South of the White Mountains is one of New Hampshire's biggest and best-known playgrounds, Lake Winnipesaukee. The lake, a few hours drive from Dartmouth College, is over sixty miles around with an indented, tree-lined shore. Life on or near the lake varies from the seclusion of an island camp to the liveliness of a few of the towns which go in for the typical tourist attractions—boat trips, casinos, and beauty contests. Winnipesaukee is surrounded by many smaller, and equally lovely lakes, all thickly settled with summer hotels and children's camps.

South of the lake region, on New Hampshire's diminutive seacoast lies Portsmouth, which is a bit of the 18th century held over to the present day. Submarine-building in the Portsmouth Navy Yard, actually across the river in Kittery, Maine, is the main industry in a city where once considerable wealth was brought by sea trade and the ship-building and whaling industries. Many old mansions are located near the harbor. Most of these "castles" of the princes of commerce, set close to the narrow brick sidewalks, are now maintained as museums by historical societies. The city

has been immortalized in the writings of Thomas Bailey Aldrich.

Just out of Portsmouth Harbor lie the Isles of Shoals, only one of which is inhabited. These islands boast of a wealth of tales about pirates and buried treasure, early explorers, and prohibition rum-runners. On Star Island are a hotel and cottages maintained for the Congregational and Unitarian-Universalist summer religious conferences. South of Portsmouth stretch the state's beaches which attract hoards of visitors. There are fashionable resorts at Rye and Jenness and a large state park at Hampton Beach, just north of the Massachusetts line. This is the area for the vacationist who likes to sun-bathe, swim, and eat lobster. Though small, the seacoast area attracts its share of the vacation throng.

Back from the coast itself are such picturesque towns as Exeter, home of Phillips Exeter Academy, and Durham, site of New Hampshire's state university. These towns have the shady streets and dignified homes that typify New England, and have, in addition, the sightly campuses.

Another campus that does credit to New Hampshire is that of Dartmouth College, crowning the banks of the Connecticut River in the west-central part of the state. The college is as near to the many picnicking and amusement spots of Vermont as to those of the Granite State. Daily many visitors come to Hanover and take advantage of the guided tours around the campus, featuring Dartmouth's Baker Library and the fine athletic facilities of the college. Both Dartmouth and the University of New Hampshire open their campuses during the summer to conference groups and special summer schools.

Many houses of historic significance are open as museums, some during the summer months only. At Center Sandwich is a Museum of Original U. S. Patent Models and a clock museum is located at Georges Mills. There are art exhibits and craft shows throughout the summer months in various parts of the state. Annually the League of New Hampshire Arts and Crafts sponsors a fair in Guilford; it also maintains retail stores for league members' wares. Summer art schools sponsor exhibitions, and galleries such as the Currier Gallery in Manchester and the St. Gaudens Memorial in Cornish have a varying program of displays.

Summer theaters flourish, and numerous water carnivals and boat races are held on the lakes. There is even a summer ski jumping event held on crushed ice in the Belknap Recreation Area. Tennis and golf tournaments, horse shows and dog shows are popular features during the summer months.

The State Planning and Development Commission, at Concord, puts out a Recreational Calendar each year which lists the dates of athletic events, animal shows, summer conferences, fairs—both the street and county varieties, and any special events of the season. Programs for the summer theaters are listed and the opening and closing dates for state-run parks.

There are summer schools and conferences, varying in length from a week to the entire summer. All sorts of people, from credit executives to camp nature counselors, from music educators to motor vehicle fleet supervisors, come together to study or confer. Writers' conferences and folk dance camps are now regular parts of a New Hampshire summer. In Peterborough there is the well-known McDowell Colony, a retreat for artists, writers, and composers who want to work without disturbances and distractions. Founded by Mrs. Edward McDowell after her husband's death, the colony provides for other artists the atmosphere the composer found so beneficial to his work.

New Hampshire is everybody's playground. The State Planning and Development Commission in Concord has issued statements showing the marked increase in the vacation industry from year to year. The Commission, always ready to provide information to any would-be vacationists, is constantly trying to make the versatile state still more attractive to natives and visitors alike.

Education for Action*

By W. L. EVERITT

Dean, College of Engineering, University of Illinois

A good educational program requires sound planning, both in the design of the curriculum and in the presentation of individual courses by the instructor. Sound planning requires a clear definition of objectives. To be effective in operation the objectives of an educational plan must be understood and concurred in by both the teacher and the student. The objectives should be limited in number but be sufficiently clear that they can be used to make decisions on methods and procedures. From an engineering viewpoint, the objectives might be considered as dimensional guides to bound the problems which are met from day to day.

Objectives which are now universally accepted in university teaching are:

1. Teach to Think.
2. Teach Fundamentals.

I propose a third objective which I believe can help us to reach sound decisions in the planning of curricula and in the conduct of individual courses. It is:

3. Teach to Achieve Action.

A particular curriculum must, of course, be planned within the framework of the profession. Within this ever-expanding framework these three objectives may bound particular problems as indicated graphically by Fig. 1.

I submit these premises:

1. The basic aim of the professional man is to achieve sound action.
2. The basic job of the teacher of professional men is to prepare his students to do this.

We must then answer the question: Does our program prepare him for the steps necessary to secure sound action?

Steps to Action

What are the steps necessary to secure action and what is their sequence? My conception of them is indicated by the chart shown in Fig. 2. The next question is: What impact does the analysis of this chart have upon an engineering educational program?

We immediately recognize that most problems develop from the experience of the past, with roots in our history. Some roots are shallow, others deep. It would appear that history—particularly that of our profession, of the Industrial Revolution, and of our social and political structure—is an essential part of the education of men who are to solve the problems of the present and the future.

We recognize next that one of the most important skills necessary for the solution of problems is the ability to formulate and divide them so that they can be tackled with the tools available. Problems are usually formulated almost entirely by the instructor. The student gets very little experience in this essential activity. Adequate planning by the instructor can correct this deficiency.

* Presented at the Educational Methods Conference, ASEE Annual Meeting, June 26, 1951.

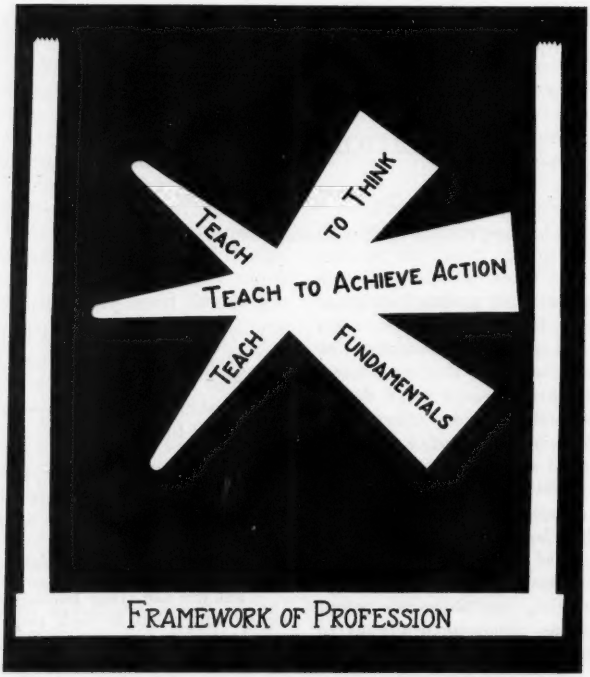

FIG. 1. Dimensional guides in the development of engineering curricula and courses.

Laboratory courses, particularly, can be so developed that only the broad purposes of the experiments may be outlined and the detailed formulation of the problems may be left to the student.

After formulating and dividing the problem, the next step is to collect information. In both laboratory and classroom instruction, we far too commonly provide the student with just the right amount of data, no more and no less. If he does not use some of the data, he feels he is in the same situation as if he had reassembled a machine and found a few bolts and gears left over. He uses this as a clue that he has made a mistake. But in an actual problem an engineer would have the whole world of information at his disposal. He inevitably collects some that he needs and some that is of little or no importance. The sorting of this into that which is relevant and that which is immaterial is an important part of his professional procedure. He also has to know how to find information which is available, what he must secure by his own experiment and observations, and how to get material from discussions with others. The art of collecting information is not intuitive but must be learned. Our educational program requires a progressive weaning process so that by the time a student graduates he is ready to proceed without too much spoon feeding or guidance.

We next observe that information must be subjected to two types of analysis. One is quantitative or mathematical; the other involves many other considerations which cannot be reduced to numbers.

Our present engineering education stresses almost entirely analyses associated with mathematical operations. Nevertheless, we know that many engineering decisions must be made on the basis of human reactions, customer appeal, labor relations, company policy, etc. It is true that this area is more difficult to teach. Skill in this type of evaluation also depends upon experience and maturity which may not be susceptible to too much acceleration. But in setting up our problems we should emphasize that, in the practice of the profession, this type of evaluation is important, and that, frequently, the skill with which it is done determines the speed and distance which the individual may move in his career. It also indicates the practical importance of the humanistic-social stem now being developed in engineering curricula and helps to convince the student that he must pay serious attention to these areas.

Analysis, whether mathematical or nonquantitative, is wasted unless it is translated into conclusions. At this point the engineer may find that something is missing; he may not have collected enough information or the right information. He may not have formulated the problem properly. This discovery indicates that he may have to go back some-

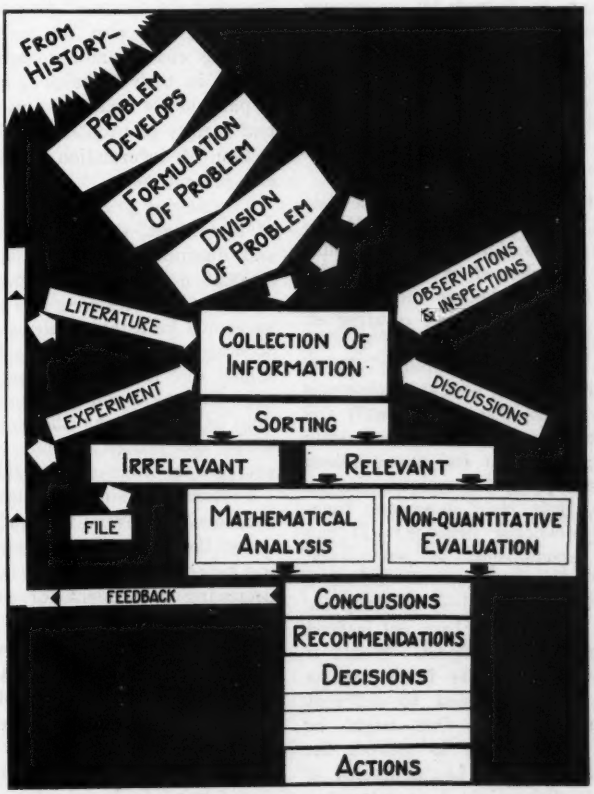

FIG. 2. Steps in securing sound action.

where along the line and change his statement of the problem or get additional information.

On the chart (Fig. 2) I have called this process "feedback" by analogy to a linkage now recognized as of great importance in many physical systems. Properly done, feedback will provide a stabilizing influence on the operation or operating system. Improperly performed, feedback may result in instability. An unstable situation in problem solving is indicated by the individual who can never reach a conclusion because he is never satisfied that he has enough data to be "sure." Engineers seem particularly prone to this fault, and students can be helped by experience with problems which do not have a unique answer, or where the information may be inadequate. Remember, engineers frequently must make conclusions on insufficient evidence or incomplete data.

Specific Recommendations

In practice, conclusions must be followed by specific recommendations for action by others. These recommendations must be followed by a whole hierarchy of decisions before they can be translated into action. The securing of decisions is usually accomplished by oral persuasion and written reports. Engineering curricula on every campus are noted (or should I say notorious?) for the number of reports which the students are required to write. But have we been using these reports for real training in persuasion, their most important function in professional practice? It can never be accomplished by stereotyped forms. We have, in general, created a paradox: we have required so many reports that our students have not learned how to write a real report. Would it not be better to require fewer reports but have them addressed to different hypothetical readers? One might be a simple memorandum to refresh the writer at a later date, i.e., addressed to himself. Another might be a memorandum to establish priority in a patent case. Another could be addressed to his technical superior. Still another might be intended to secure agreement with his recommendations by both an engineering supervisor and a non-technical officer of his company. Finally, he might prepare a report of a technical development for presentation to a service club. Varying the hypothetical reader and the aim to be accomplished would give him experience in reducing his conclusions or observations to writing that is focused and effective.

Ultimate improvement in engineering education must depend not merely on changing the names of courses within the curricula, but also on the method of teaching courses now recognized as essential in their technical content. This is particularly true if we are to develop real facility in problem formulation, collection of information, broad analysis, and presentation.

Engineering practice involves processes of integration, the use of many sources and disciplines to supply a service or machine useful to man. Even when we are working or teaching in a limited area, we should keep the problems of synthesis or integration illustrated by the chart of Fig. 2 well in mind. It would also appear that we should give more consideration to teaching by the "case method" which has proven so effective in other professional curricula, notably law.

Fortunately, since problem-solving is a necessity in every form of human activity, the proposed objective of "Teach to Achieve Action" gives guidance in preparing the student for educated citizenship as well as for a professional career. Hence, this presentation should not be interpreted as a plea to educate only in practical fields, except as all education which is related to living may be considered practical.

I realize that not all the items discussed here can be introduced into every

course. They will be more difficult to incorporate in sophomore physics than in senior courses. I also recognize that a program taking these ideas into account may be more difficult for the instructor, particularly in the problems of grading. But if our objectives are clear to our students and are acted upon by our faculty, marked progress can be made even within the confines of the existing shortage of time in our engineering curricula.

In summary, the objective "Teach to Achieve Action" indicates that the following items are important in both our curricula and course planning:

1. Knowledge and appreciation of history.
2. Formulation of problems.
3. Collection of information.
4. Distinguishing the relevant from the irrelevant.
5. Non-quantitative evaluation, particularly involving human reactions, as a companion of numerical analysis.
6. Translation of analysis into conclusions which are then reduced to specific recommendations.
7. Oral and written presentations in a form designed to accomplish a clearly perceived, practical purpose

James H. McGraw Award in Technical Institute Education

The purpose of this award is to recognize and encourage outstanding contributions to technical institute education. Candidates for it may be teachers, authors, or administrators who are, or have been, affiliated with an institution which offers or sponsors training of the technical institute type.

This is an annual award of the sum of $500, and it is made at the annual dinner of the Technical Institute Division of the American Society of Engineering Education each June. It is made upon the recommendation of the James H. McGraw Award Committee, members of which are appointed annually by the President of the American Society of Engineering Education. Nominations for the award should be sent to the Chairman of the Committee, Professor H. P. Adams, Oklahoma A. & M. College, Stillwater, Oklahoma, by March 15, 1952. The award is made possible by the McGraw-Hill Book Company in memory of James H. McGraw.

Cooperative Graduate Study*

By N. W. DOUGHERTY

Dean of Engineering, University of Tennessee

At the Fontana meeting last summer we made a brief report regarding possible cooperation on a graduate level with such agencies as the Tennessee Valley Authority. After the meeting at Fontana we have made some further exploration of this problem.

A few of those present at Fontana attended a meeting of the Board of Control for Southern Regional Education at Daytona Beach, Florida in early September. One of the topics for discussion was possible cooperative graduate study with industry. The writer served on one of the work committees for the three days of the conference. A statement of principles which should be used in developing such a program follows:

1. That the primary conception of the utilization of agencies in graduate education by institutions is founded on the realization of mutual benefit, and that the institution-agency relationship is consistent with the educational purposes of the institutions and the respective purposes of the agencies.
2. That the responsibility for awarding academic degrees shall reside in the institution. In this connection the institution will approve standards of instruction and programs of study and research, and will be responsible for the evaluation of student accomplishments, including the research entering a dissertation from the point of view of its acceptability for satisfying institutional requirements.
3. That there should be developed proper standards for acceptance of residence credit for work done in the agency under programs approved by institutions and agencies.
4. That the institution shall approve the eligibility of the agency staff to guide and to assist in the direction of research, including thesis research, and shall recognize the desirability of agency staff participating in the final examinations of students whose research they have guided.
5. That the agency shall have the right of approval of institutional staff and of graduate students for work within the agency.
6. That there shall be prior mutual agreement between the institution and the agency on policies governing the publication of research findings.
7. That there shall be ways provided for the exchange of information between institutions and agencies relative to research in progress and other educational opportunities in which both may be concerned.
8. That opportunity for work in agencies shall be sought for full-time teachers as a means of broadening their professional experience and increasing their teaching proficiency. Conversely, that opportunity for academic work in institutions shall be sought for agency staff as a means of broadening their professional experience and increasing their technical proficiency.

* Presented at a meeting of the Southeastern Section of ASEE, Biloxi, Mississippi, March 24, 1951.

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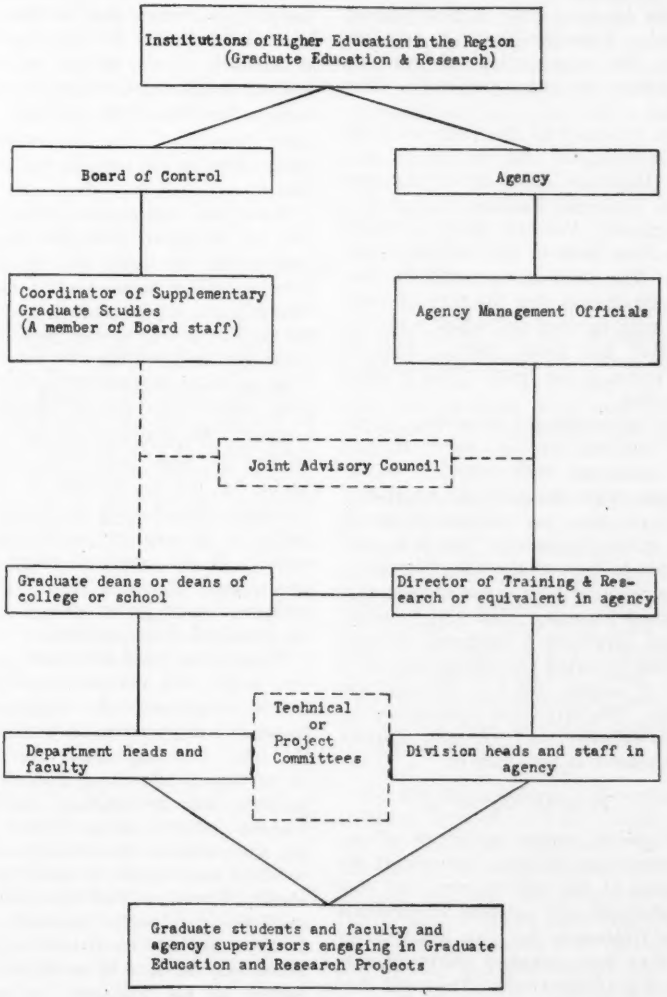

Institutions of Higher Education in the Region
(Graduate Education & Research)
Board of Control
Agency
Coordinator of Supplementary Graduate Studies
(A member of Board staff)
Agency Management Officials
Joint Advisory Council
Graduate deans or deans of college or school
Director of Training & Research or equivalent in agency
Technical or Project Committees
Department heads and faculty
Division heads and staff in agency
Graduate students and faculty and agency supervisors engaging in Graduate Education and Research Projects

The Board of Control will undertake to bring an agency in contact with the member institutions; after the contact has been made, the program will be developed by the institutions themselves in cooperation with the agency; and there will be no effort on the part of the Board of Control to dictate policies regarding either the graduate work or the possible thesis work in industry. Representatives of the Tennessee Valley Authority were present at the meetings and they made

excellent contributions to the deliberations. A representative was also present from the Air University at Montgomery, Alabama. Attached hereto is a chart showing the organization of graduate work under the plan proposed. (See page 3.)

After returning to Knoxville we made some explorations with industries such as the Aluminum Company of America and the Tennessee Eastman Corporation at Kingsport. We had rather favorable replies from most of the industries contacted. The problem apparent in each of the discussions was the type of work which could be done and which would be acceptable for thesis credit. This, it seems to me, is the heart of the possible cooperation.

After reviewing the discussion at the ASEE national meeting last year, and after discussions with industry, we, at Tennessee, have come to the conclusion that more than one institution should try a pilot program in this field, and undertake to discover the difficulties which may be reported back to the colleges at a subsequent meeting. With this in mind, we have developed a program and will undertake it during the coming year, provided, of course, we can get graduate students. We have made some announcement to industry, and will make further announcement as time goes on.

Program Outline

Our present concept is that we will accept competent graduate students at the beginning of the Fall quarter, and that these students will continue in residence at the University for two quarters, or until they have acquired thirty quarter hours of graduate credit. They will then be placed in industry for six months. A faculty member of the institution will confer with a scientist in the industry on the possible thesis problem. The amount of credit that will be given for the thesis will be determined in advance, and the student, after he has begun his work in industry, will begin reports back to the faculty member in the University. If the problem is such that he can complete his writing during the six months stay in industry, all will be very well. If he has not completed his thesis he may return to the University and stay a sufficient amount of time to complete the study; then he will take his oral examination.

Since our requirement is the equivalent of forty-five graduate hours, this means that the thesis may be given as much as fifteen hours credit. Less than fifteen hours, of course, will require that the student return to the University and take more course work.

It has been difficult to set up a program which will have an appeal to the student. Our graduate council has been willing to give one-quarter residence credit for the six months of industrial residence, provided the work done in industry is of a caliber to warrant thesis credit. If no credit is given for the thesis, then of course there will be no residence credit going with it. This is the loose end of the program.

We are convinced that there are problems in industry and methods of cooperation which will allow the student to satisfactorily complete a thesis while he is on the job. Our experience, for example, at the Norris laboratory indicates that a problem may be selected which is of interest to the Tennessee Valley Authority, and certainly of sufficient importance to allow the student to work for thesis credit. I am sure that there are certain problems in design, especially in the fields of civil and mechanical engineering which may be done by a student and reported to his professor for graduate credit.

Industry is very anxious to find employees from any source. This may be a part of the reason for their optimism in stating that they are willing to start the cooperation. It is our hope that we can develop the work in industry to such a

point that it will contribute to the graduate education of the student. If this cannot be done, then a graduate program in industry will be of very doubtful value, except as a possible source of earnings to complete the rest of the program back at the university in residence.

We invite comment on, and criticism of, the plan. We hope that within a year or two of trial we can report back that the scheme is workable. We will be very glad to exchange information and experience with any other college of engineering which will undertake such a program.

College Notes

The governing board of the **Colorado Agricultural and Mechanical College** at Fort Collins has approved the offering of a Ph.D. in Irrigation Engineering. This is the first doctor's degree to be offered at the College and is in a field for which it has achieved a notable record since 1887. The degree will be administered in the department of Civil Engineering, which has been offering advanced work in Irrigation Engineering for a number of years. The work will be given in conjunction with programs of the Irrigation Institute. These are broad and intended to cover all aspects of the field of irrigation agriculture. In engineering it can include theoretical or applied fluid mechanics, design, soils and water, operation and management, or project planning.

Dr. Paul E. Klopsteg, Professor of Applied Science and Director of Research of Northwestern University, has been appointed Assistant Director of the **National Science Foundation** for the Division of Physical, Mathematical and Engineering Sciences. This Division is the largest in scope of the Foundation's four science divisions. With the aid of expert consultants representing the various scientific areas included in his division, Dr. Klopsteg plans to begin work immediately on a program of research support in these areas.

Carnegie Institute of Technology has received a $300,000 grant from the A. W. Mellon Educational Charitable Trust to permanently establish A. W. Mellon scholarships. The grant is in the form of an endowment, income from which will be used by the school to help approximately 35 deserving students each year. Established in 1938, the scholarships were maintained until now by yearly grants from the Mellon Trust.

An $80,000 scholarship program, designed to help alleviate the critical shortage of industrial engineers, has been initiated by the Reliance Electric & Engineering Company. The program provides for the admittance of eight qualified high school graduates annually to the School of Engineering of **Fenn College.**

Extension Instruction in Engineering

By C. W. BEESE

Dean, Technical Extension Division, Purdue University

A program of instruction in "mechanics" or comparable technical courses and which is within the broad field of "adult education" is sufficiently important to warrant analysis of the influencing factors which determine the feasibility of such a program. There are some fundamental considerations which more or less determine the characteristics of a program of this kind. These considerations may be used to evaluate any adult education situation and arrive at a recommendation based upon the relative importance of the factors involved in a situation under study.

Dr. Holt's discussion describes a solution to an adult education need arrived at in a situation where the schools and the industries served are located in close proximity. The programs which he outlined have proved by experience that they serve effectively the needs of the students and the industries and safeguard, at the same time, the academic respectibility of the universities involved.

Fundamentally any adult education must be satisfactory to the student, to his employer, and to the sponsoring educational unit. The program must be satisfactory as to quality, appropriateness and cost. It arises from a need by qualified students expressed in a desire for culture or for vocational proficiency. The need may be translated into an operable program providing qualified teachers are available, physical facilities are at hand, and the cost of the program is such that economically it is possible through fees or subsidy.

This discussion will review the circumstances which determine whether engineering subjects can be taught within an adult education program at an acceptable cost level and with academic respectibility. Important factors are the numbers and qualifications of prospective students, availability of an acceptable teaching staff, the demand for instruction as it is translated into subject matter areas, relative geographic locations of the institution and its branches and the students at work and at home, fiscal policies as to fees and subsidy for instruction and procedures of operation, both academic and financial.

Some limitations which affect adult education in the fields of engineering are not of importance with regard to general adult education activities. In the subject matter areas of engineering, whether in mechanics or some other subject, it is ordinarily true that satisfiable needs exist mainly in an industrial concentration. Such a concentration of industry is more important when it uses much engineering and many engineers. It is in this situation that needs for further study arise from the desire on the part of engineering personnel for job advancement, because the industry must offer educational opportunities as an inducement during recruiting or because industry requires technical training in order to conduct its business.

An engineer interested in further study is fortunate if his residence and

* Presented before the Engineering Mechanics Division at the 59th Annual Meeting of the ASEE, East Lansing, Michigan, June 29, 1951.

his job are located close to an institution of engineering education. It is possible to pursue in evening classes many of the subjects given to campus students on a schedule which does not interfere with full time employment. Campus facilities in laboratories and campus teaching personnel are available for evening instruction. Where part-time or visiting lecturer instruction is used, the supervision from the subject matter department is relatively simple.

The student employed by an industry in a locality where there is no technical educational institution is up against quite a different proposition. He, or the educational facility, must travel. If he is one of a small number, the possibilities of his getting instruction at home are none too good. If he is one of a large group, it is economically possible to bring the instruction to him. The type of program, the subjects offered, the level of instruction, the fees charged are all affected by a need for instruction at a locality other than where an engineering institution is located.

Responsibility of Subject Matter Department

The subject matter department must be thoroughly convinced of the worthwhileness of adult education. It must recognize that the activity is just as respectable and must as honestly carry the stamp of approval as if a class were on the campus. The assumption of responsibility by the subject matter department for quality of instruction means a very close contact with the teacher, a check on the qualifications of the students, and a thorough understanding of the problems involved in the operation of the class. A campus teacher may never receive a critical visit from his department head. On the other hand, an off-campus class in a catalog course or an adult education class which is outside of the regular catalog listing needs and should get close supervision of a helpful type.

The responsibilty for an adult education class in engineering on the campus or at some distance from it involves many of the sub-divisions of the sponsoring institution but it is generally accepted that the subject matter department assumes the major responsibility with regard to instruction. This responsibility involves the educational aspects of the class such as the quality and level of instruction, course content, use of text and supplementary reading, the selection and supervision of teachers, and the quality of instruction with respect to its suitability to meet the recognized need.

When the educational institution gives no credit for the class work and the students are satisfied that they are getting what they want at a cost which they are willing to pay, supervision is less critical. However, if credit, either undergraduate or graduate, is involved then the university must not only satisfy its own requirements but put its label only on educational achievements which may be certified to another institution with a guarantee of quality.

The selection of a teacher for an adult class may be more critical than for a class of undergraduates on the campus. Undergraduates take courses in a fixed curriculum and credit in courses must be obtained in order to receive a degree. On the other hand, adults take work because they feel they are getting a fair return for their investment in time and money and are quick to complain about or drop out of a class if they are not happy. The teacher is more frequently on the spot than the student. It has been said that on the campus, the teacher flunks the students but in adult classes, the students flunk the teacher.

The choice of a part-time teacher from industry is important too and just as critical. Many persons from industry know subject matter. But in addition they should be able to handle a class with some degree of facility. A teacher, whether he is from the campus or from industry, must be able to point his course

to meet the needs and level of preparation of his students.

A teacher of an adult education class must frequently furnish much more material in the form of teaching aids and supplementary reading than if he were handling a campus class. Adults are strongly motivated, but, on the other hand, do not have the study facilities nor are they in the study habit like undergraduates. The teacher need not necessarily go more slowly but he needs to guide just as carefully.

Adult education as it is usually defined includes a wide variety of offerings. When the program is within the fields of engineering the course offerings are usually those found in a university curriculum. These courses may be for credit or they may be without credit. Primarily this choice depends on the use which the student wishes to make of the training he receives. Work taken "for credit" usually means that the credits received are applicable to some kind of a degree. This may be an undergraduate degree or an advanced degree obtained through graduate level study.

Work of this kind in engineering subjects is more frequently found in organized classes conducted similarly to the way classes would be held on the campus. There is, however, some work given through correspondence and while this may be the smaller amount, it is an important type of instruction.

Credit and Non-Credit Courses

In a group of persons interested in engineering study, there is usually a mixture of those who want credit toward an immediate or a possible degree objective and those who are interested in study for the sake of personal development alone. It is not always possible to organize these groups separately. In other respects they may be quite homogenous and the total group if split in two is not financially economical. It is not as important to scrutinize the qualifications of persons who are not interested in credit. If they have a background such that they may profit by as much or as little as they wish to do and are willing to carry the cost financially, there is no good reason why they should be denied the privilege of going to class. On the other hand, a mixture of both groups in a class may cause difficulty. Persons less qualified and who join classes as visitors or non credit students may monopolize an instructor's time if it is permitted. If they are less prepared, they make it difficult for the teacher to hold instruction to a "credit" level. A visitor in a class ordinarily has no rights with regard to discussion or individual attention, except what he may contribute to the general fund of information. The teacher has to recognize his responsibility to those who are obtaining work of a pre-determined level of quality and quantity. He has much less responsibility for recognizing the visitor except as a listener. A sprinkling of non-credit or visitor students may be beneficial but where separate classes can be developed, it is preferable.

Special courses can be organized for students of a specific industry. Problems may involve operating practices within a plant and the class itself may be held within the plant. Closed classes have certain advantages. Where the teacher is familiar with the situation within the industry, he may make the class much more worthwhile than if it is a general one. Locating the class within the plant saves time of the students and if the instructor may come to the class an overall saving can result.

Public institutions are not in a position to offer closed classes exclusively. Any industry and any individual have equal privileges. A closed class, therefore, offered for the employees of a company must, in most cases, be duplicated by an equal opportunity for other persons who wish the same opportunity.

Most universities have rules which require that a certain proportion of the work toward a degree must be taken

"in residence." The proportion of residence instruction varies from one institution to another. The primary consideration is that a student shall be connected with the institution long enough to get the feeling obtained through contact in and out of class with campus teaching personnel. It is possible to make arrangements so that the complete program may be taken away from the "campus" if work is done in connection with established facilities for instruction.

Student residence is an important consideration for adult education classes. Persons most likely to benefit by further study have jobs and are barred from attendance at a distant class because of job limitations and travel time. Few people can take a semester or a year away from the job to do graduate work. A larger number of persons can benefit by stretching a graduate program over a period of years and continuing with the job at the same time. It is felt that a lessening of the so called residence requirements is justified if suitable safeguards are taken at the same time to insure that the students' qualifications and the quality of instruction are satisfactory.

Promotional Techniques

Adult education, in spite of a general acceptance of its value, must be sold to prospective participants. Evening classes must be made attractive enough to compete successfully with a host of off-the-job activities. Schools try a combination of all the good promotional techniques that they can afford.

Announcements by mail, by poster, by word of mouth, and by suggestion through employers are all important. Such announcements must go to qualified persons in a way which will persuade them to make a major assignment of what would otherwise be recreational time to an activity which, while it may be stimulating, is confining to an annoying degree.

The teacher, his personality and the job he does have a lot to do with the enrollment of repeat courses. This is an element of major importance affecting the value of the instructor to his employing institution.

Registration procedures in cases where credit is involved can follow closely the procedures on the campus. Registration involves recording the information concerning the student himself, the courses he is taking, and the collection of fees. Handling money away from the bursar's office on the campus may involve taking care of money in an out-of-the-way location and at times of day which do not coincide with banking hours. All of these problems are of a business nature, ordinarily do not concern the teacher on the campus at all, and should not be thought of with respect to the total responsibility of the subject matter departments.

Adult education classes are held in a variety of locations. School houses, industries, or almost any suitable space may be used where it can be rented or obtained on a loan basis.

One of the arrangements which involves not only the business of providing facilities but the responsibility of the academic units of the University is the provision of satisfactory library facilities. These may be furnished in a number of ways but are important enough so that some provision should be made for them.

Financial Arrangements

It is generally recognized that adult education activities must support themselves financially though to a varying degree. Few institutions can afford to subsidize such a program beyond furnishing some overhead items. Fees ordinarily carry the direct cost of the teacher and other items directly chargeable to the class, and must carry a contribution toward general overhead as well. The amount of money involved depends, to some extent, upon the type of teacher used in the class, travel cost and some lesser items.

When a campus teacher travels from his home base for a distance which in-

volves a considerable expenditure of his time, the demands of an adult education assignment may be out of proportion to those of a comparable class within his normal campus environment. From one viewpoint, it is only fair that the off campus class carry that proportion of the instructor's salary in ratio to the amount of his total time consumed by the class. This may be a prohibitive charge and can be met only if fees are abnormally high or if classes are larger than good teaching practices ordinarily recommend. Charges for travel may be a sizeable item of cost.

The part-time teacher who has no travel involved, and who may be expected to charge against a class an amount comparable to his effort tempered somewhat by his interest in doing the job, can be handled much more cheaply than a campus teacher. At the same time, this person may require much more supervision than the campus man. Arrangements as to pay for the teacher and the collection of the fees to meet this cost come within the business aspects of the adult education program.

As far as the university is concerned it makes little difference whether the student pays the fee as an individual or whether his employer subsidizes part or all of it. Perhaps the accounting is a little more complicated if the arrangement is flexible but this affects only procedure. For the moment, at least, a more serious complication is where the cost of instruction is borne wholly, or in part, by the Veterans Administration through the subsidies of their program. The university becomes involved in the collection of amounts due for books as well as instruction and must maintain the type of record which bears government scrutiny.

Where off-campus instruction must carry its own weight financially, there is a temptation to develop classes of abnormal size because it is much more economical to teach large groups. Teacher costs for accepted travel and salary are no more for a large class than for a small one. It is accepted that some subjects may be taught in large units. This is not so true in connection with engineering or other technical topics. The size of the class as it actually develops is a compromise between the class large enough to carry the cost of instruction at a reasonable charge per student and the class small enough so that the quality of instruction is satisfactory. It is difficult to set arbitrary figures but, on the other hand, if reasonable consideration is given to the two opposing factors, the resulting answer is not too far wrong.

Where work is taken for credit, the record of accomplishments is logically a part of the registrar's responsibility as if the student were an undergraduate on the campus. Admission requirements especially for graduate students can satisfactorily follow the same procedure as for full time students on the campus. Requirements for degrees and the degrees granted need bear no unusual designation since no actual difference exists in the kind of study program completed.

Low income and high teacher costs for small classes make it difficult for the lone student in a small population area to get the advantages of further study. For him home study methods offer some advantages. There are many subjects where instruction is difficult. On the other hand, this type of instruction is much more valuable than is generally recognized.

Developing a correspondence course means a sizeable investment which must be returned through enrollment fees within a reasonable length of time.

Summary

In summarizing, it may be pointed out that an adult education program can include many offerings in engineering and associated subjects. Such offerings may be at undergraduate and graduate levels, either with or without credit toward a degree. In some situations, such instruction presents little difficulty; in

others it becomes much more complicated and may require some compromises with campus procedures. However, if there are qualified students in sufficient numbers to pay costs, an acceptable teacher available, and proper supervision by campus subject matter departments and business offices, a substantial amount of adult education in engineering is entirely practical. A plan flexible enough to adjust to varying situations can be operated with complete academic respectability and perform a tremendous service to persons who require additional education to advance in the technical environment in which they are employed.

In the News

The $3,500,000 appropriation for the National Science Foundation in the Supplementary Appropriation Act of 1952, will enable the Foundation to start immediately on its two major operating programs: support of basic research in the sciences and training of scientific manpower. Up until now the Foundation has been concerned primarily with planning and with the problems of organization and staffing prior to beginning its operating program.

The reduction in the appropriation from the President's budget request of $14,000,000 for fiscal 1952 has required material scaling down and adjustment of the program originally presented to the Congress. According to Dr. Alan T. Waterman, director of the Foundation, approximately $1,500,000 of the available funds will be allocated for the support of basic research in biology, medicine, mathematics, the physical sciences, and engineering; about $1,350,000 for the training of scientific manpower; and the balance for development of a national policy for the promotion of basic research and education in the sciences, for the wider dissemination of scientific information, and for other services including support of the National Scientific Register, now established in the Office of Education.

Basic scientific research will in most cases be supported by means of research grants. No grants have been made to date, although a considerable number of research proposals have been received from investigators in all parts of the United States. It is expected that many more proposals will be received shortly.

Proposals for research grants will be given preliminary evaluation and review by the Foundation's three research divisions: the Division of Biological Sciences under Dr. John Field, the Division of Mathematical, Physical and Engineering Sciences under Dr. Paul Klopsteg, and the Division of Medical Research under Dr. John Field (acting). Each Division will be assisted in evaluation and review by a Divisional Committee, made up of outstanding scientists in the field, and by expert consultants employed on a part-time basis. Grants will be approved by the Director and the 24-member National Science Board, whose chairman is Dr. James B. Conant, president of Harvard University.

The National Science Foundation Graduate Fellowship program will be directed by the Division of Scientific Personnel and Education under Dr. Harry C. Kelly. Selection of fellows will be made solely on the basis of ability and will be carried on by the National Research Council, which has participated in the selection of fellows for various government and private agencies for many years.

Applications will be considered from students in the natural sciences who have or will have completed their undergraduate work in any accredited college or university. Fellows may attend any accredited non-profit institution offering graduate studies in science which approves their application for admission.

A Study of the Correlation Between Sophomore Achievement Test Scores and College Grades

By J. A. HILL

Director of Student Personnel and Admissions, New York University College of Engineering

The Sophomore Achievement Tests have been developed by the Measurement and Guidance Project in Engineer-Education to provide measuring instruments of value in testing students for promotion and testing applicants for admission to engineering colleges with advanced standing from liberal arts and junior colleges. The first version of the tests was made available in the spring of 1948; revised tests were available in the spring of 1949 and 1950.

This study is based on the results obtained when the tests were given on March 29, and 30, 1948 to students in the College of Engineering, New York University, who at the time were in the latter part of their sophomore year. Although 252 students took the tests, the sample group numbers only 87, for the reason that this study grew out of a larger investigation, which required that the students have taken other psychological tests in addition to the Sophomore Achievement Tests. This factor introduced no selectivity and should have no effect on the results.

The tests were all of the achievement variety and included the following subject areas, with time allowed: English Expression, 55 minutes; Engineering Drawing, 50 minutes; General Chemistry, 90 minutes; Mathematics, 120 minutes, and Physics (Mechanics), 60 minutes, a total of 6 hours, 15 minutes.

In this study the degree of correlation between college grades and test results is measured, in each of the five subject areas, and also on a composite basis. The relation is expressed mathematically in each case by computation of the coefficient of correlation (r), and is also expressed graphically in each case by means of a "scatter diagram."

The coefficients of correlation between college grades in the several subject areas and the test scores in those areas have been computed as follows. (A widely accepted verbal description of the meaning of correlation coefficients states that "substantial" correlation is indicated when "r" is from .50 to .80, and "some" correlation when "r" from .30 to .50.)

Chemistry	r = .58
Engineering Drawing	r = .44
English	r = .42
Mathematics	r = .48
Physics	r = .50

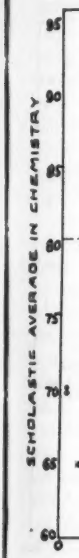
The coefficient of correlation between the composite test scores and the students' scholastic averages at the end of the sophomore year is:

Overall	r = .58

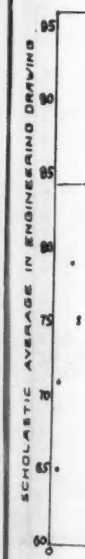
The composite percentile score is the average of the percentile scores on the five subject matter tests.*

The scatter diagrams (Charts 1, 2, 3, 4, 5) portray graphically the relationship

* The obtained correlation coefficients reported here are perhaps slightly lower than they would have been had not certain minor liberties been taken for practical reasons in the use of the product-moment theory.



CHART



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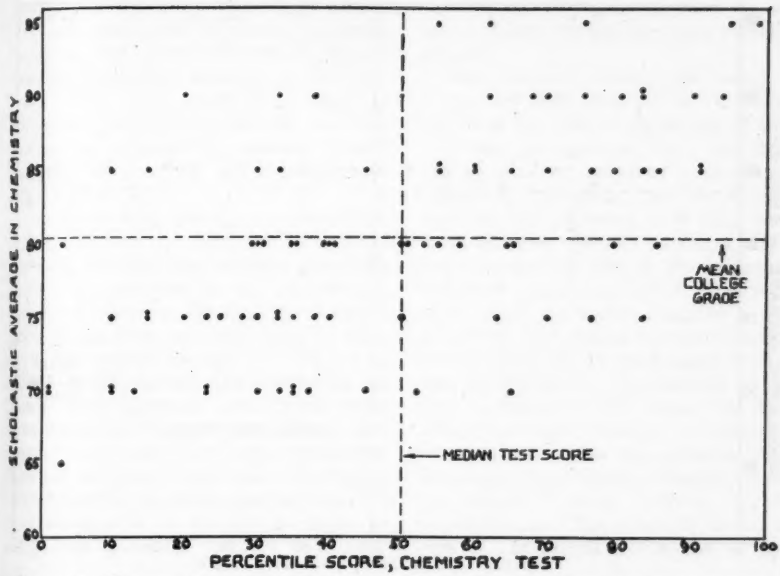

CHART 1. The correlation between scores on the Chemistry section of the Sophomore Achievement Tests and College grades in General Chemistry.

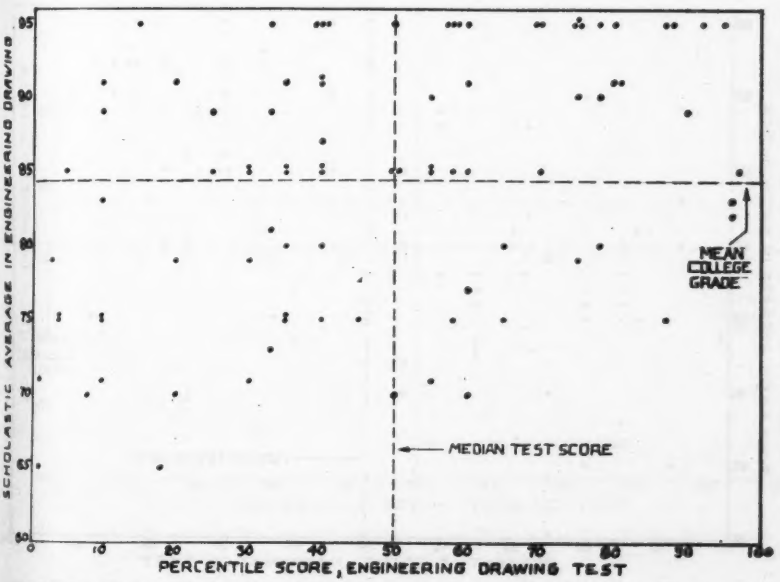

CHART 2. The correlation between scores on the Engineering Drawing section of the Sophomore Achievement Tests and College grades in Engineering Drawing.

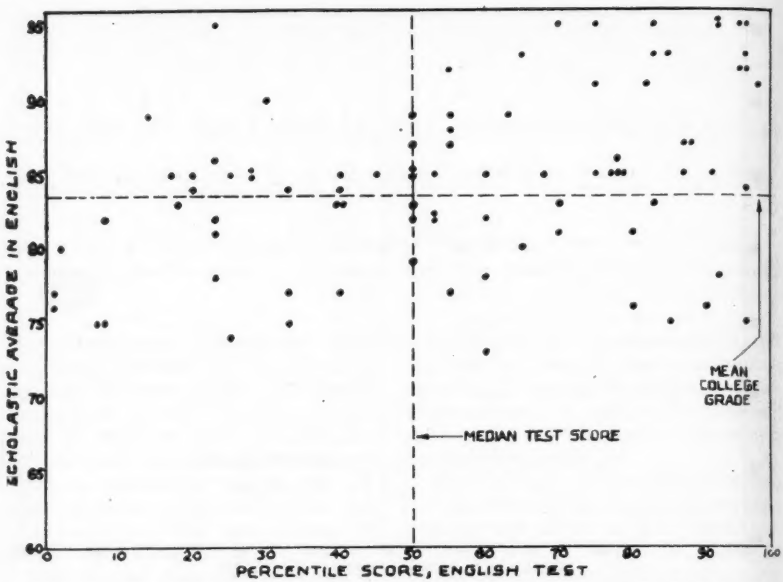

CHART 3. The correlation between scores on the English section of the Sophomore Achievement Tests and College grades in English.

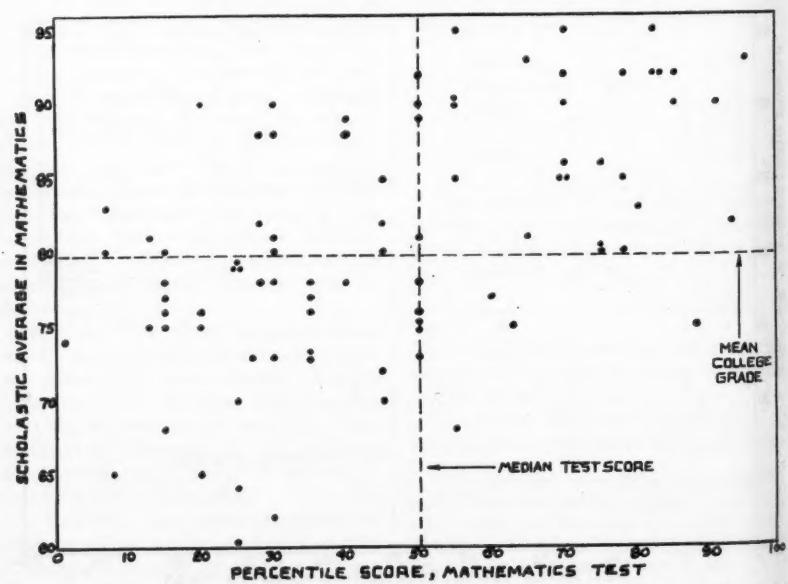

CHART 4. The correlation between scores on the Mathematics section of the Sophomore Achievement Tests and College grades in Mathematics.

between the test scores and college grades. In each case, the student's percentile score on one of the achievement tests is plotted against his average in that subject. The same treatment is used to show the relationship between the composite test score and the student's overall average at the end of his sophomore year (Chart 6).

If there were perfect correlation between the two variables, the dots should form a straight line running from the lower left quadrant to the upper right quadrant, passing through the intersection of the 50th percentile line (x axis) and the group average (y axis). In broad simple terms, dots falling in the lower left quadrant and upper right quadrant are "in phase"; those in the upper left and lower right quadrants are out of place. The dots in the upper left quadrant represent students who did not do as well on the test as might be expected, while the dots in the lower right quadrant represent students who scored higher on the test than would be expected.

The percentile scores are based on norms for 3668 students at 10 colleges who took the tests in the spring of 1948.

It may be observed from the charts dealing with the individual subject areas, (Charts 1 through 5) that the dots are quite widely dispersed, and that in almost all cases there is a comparatively large number of dots in the upper left quadrant and in the lower right quadrant. This dispersion indicates a comparatively low degree of discriminatory power and might be interpreted to mean that the individual tests could not be used with confidence for the purpose of measuring past achievement in, or predicting future performance in, individual subject areas. An exception to this generalization should be made, however, for the Chemistry test. The relatively higher degree of correlation of this test, as com-

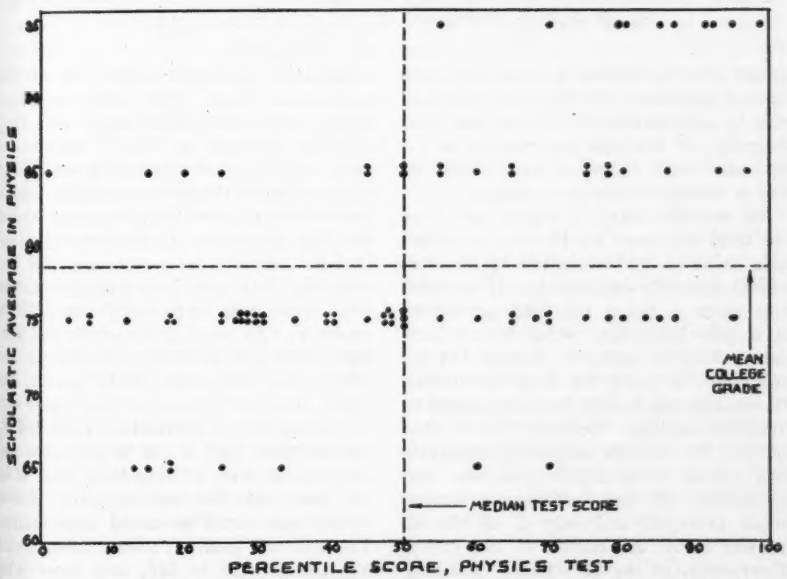

CHART 5. The correlation between scores on the Physics section of the Sophomore Achievement Tests and College grades in Physics (Mechanics).

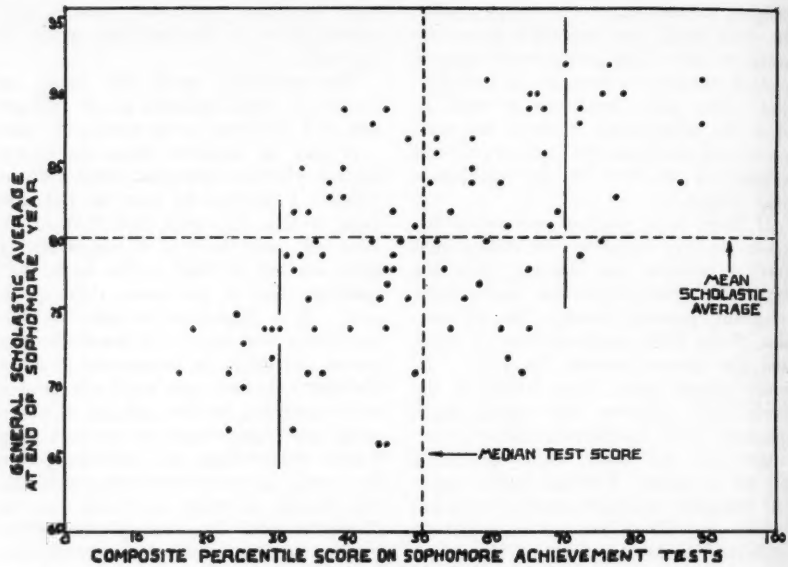
GENERAL SCHOLASTIC AVERAGE AT END OF SOPHOMORE YEAR
MEAN SCHOLASTIC AVERAGE
MEDIAN TEST SCORE
COMPOSITE PERCENTILE SCORE ON SOPHOMORE ACHIEVEMENT TESTS

CHART 6. Showing the correlation between total Sophomore Achievement Test scores and overall scholastic averages at the end of the Sophomore year.

pared with the others, is apparent upon careful examination of the charts. It might also be appropriate to interject here that diagrams of the type used should be interpreted with discretion as a visual illusion factor is sometimes present.

On the other hand, it may be seen that the total test score would be of considerable value in the evaluation of an individual student's attainments. If his total test score is below the 30th percentile, it is quite likely that he has been an unsatisfactory or mediocre student. If his test score is above the 70th percentile, the chances are that he has been a good or excellent student. Note on Chart 6 that of the 12 students attaining composite test scores at or higher than the 70th percentile, all had satisfactory sophomore averages, and only 2 of the 12 ranked below the middle of the group. Conversely, of the 11 students attaining composite test scores at or lower than the 30th percentile, all except one had unsatisfactory averages at the end of the sophomore year. The one exception barely attained satisfactory standing with an average of 75%. Stated another way, a good student is not likely to score below the 30th percentile, and a poor student is not likely to score above the 70th percentile. In the cases of those students whose total test scores fall betwen the 30th and 70th percentiles, the test score will apparently have little meaning. As seen in Chart 6, the college records of students who scored between the 30th and 70th percentiles range from very poor to very good.

The degree of correlation achieved is just about as high as can be expected for a group of tests of this kind, and it is not likely that the discriminatory power of the tests could be raised appreciably. The tests will pick out those students who are almost sure to fail, and those who are excellent bets to perform satisfactorily, but will not draw a line above

which all good students will score, and below which will be found the scores of all the poor students.

The practical value of the Sophomore Achievement Tests would seem to be confined mainly to the selection of applicants for admission with advanced standing. After an engineering college had developed its own norms, the test would facilitate evaluation of transfer applications.

Conclusions

The individual tests showed little discrimatory power. Test scores and college grades in particular subject areas correlated well in the upper ranges, but not too well in the middle and lower ranges.

The high degree of correlation between composite test scores and college averages in the extreme upper and extreme lower ranges seems to indicate that the tests would be useful in the selection of applicants for admission from two-year pre-engineering programs. The tests apparently will pick out those students who are almost certain to succeed, and those who are almost certainly doomed to failure.

September 21, 1950.

In the News

Sixty-seven young Britons, including one woman, have arrived at various universities in the United States under a Marshall Plan program of academic and in-plant training in industrial management and engineering.

The training in the United States, with dollar costs financed by the Economic Cooperation Administration under its technical assistance program, is expected to help increase productivity in British industry by providing a nucleus of industry executives trained in the latest management and engineering techniques. Eighty-six British trainees have previously come to the United States under this program. Some of these have completed their work and have returned home, while others are still here.

Sixteen of this group will study at Syracuse University, the 18 others at the University of Cincinnati. The plant visits will be in the respective areas of the two universities. The program is supervised by the National Management Council for ECA.

The 33 engineers in the other group have qualifications similar to those in the management group in their own field, and they also have agreed to return to their positions in the United Kingdom.

Their program, arranged by the Institute of International Education for ECA, consists of individual studies in the respective fields of the participants. These include electrical, civil and mechanical engineering, mining, textiles, petroleum refining, aeronautics, metallurgy and chemistry.

The academic part of their training will in most cases be for one semester, at 21 U. S. universities, colleges, research foundations and technical institutes. The balance of the training will be practical, at industrial plants or public works agencies. In two cases, trainees are starting the program with the practical training rather than the academic work.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

NOMINATION BLANK

"ARTICLE XI, Section 3. (Election of Officers) By means of a form to be printed in The Journal of Engineering Education or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for said officers. These names, on the form provided, shall be sent to the Secretary of the Society not less than sixty (60) days prior to the annual meeting; and the Secretary shall submit the suggested names to all members of the Nominating Committee."

In order to make the election of officers of the Society as democratic as possible, members are urged to fill out the nomination form and return before April 15, 1952 to the Secretary, A. B. Bronwell, Northwestern University, Evanston, Illinois.

I nominate the following members of the Society for officers:

For President .....

.....

For Vice-President .....
(In Charge of Instructional Division Activities—two years)

.....

For Treasurer .....

.....

Signed .....

Title .....

Institution .....

Date .....

The Graduate Program in Industrial Engineering at the Ohio State University*

I. Graduate Work in Methods and Standards

By HAROLD O. DAVIDSON

Instructor in Industrial Engineering, Ohio State University

While the title of this paper refers to what is administratively defined as the Methods and Standards area, a precise delineation of this area in terms of graduate work is rather difficult. At first, "Methods and Standards" was selected merely as a better name for what is commonly included under the title "Time and Motion Study." As our graduate research progresses, however, we find ourselves led into zones which are either ignored or but superficially touched upon in what is contemporaneously known at Time and Motion Study. In discussing graduate work in the Methods and Standards area, therefore, we are defining the title broadly to include whatever we may be led into through fundametal investigation of the problems.

Objectives of Advanced Study

If a clear understanding of our graduate work is to be conveyed, it is perhaps desirable that we next define the objectives of advanced study. We believe that the qualified candidate for a graduate degree should possess a broad perspective of his general field and its functional relationship to industry and society, together with a critical comprehension of the problems and techniques within his area of intensive study. He should be able to plan and conduct original investigations and to report them in a manner which exhibits logical thought and competent use of the English language. These objectives are fairly well summarized as: background knowledge, analytic ability, and facility in communication. In addition to these there is one other objective for which we hold ourselves responsible. We must utilize the superior talent and abilities of our graduate students toward the fundamental advancement of the area. Considering the retarded development of this area in comparison with, say, Quality Control, we cannot afford to waste intellectual ability on trivial investigations, surveys, and the like. The record of the past several decades suggests rather strongly that we cannot expect fundamental development from the practioners in the area.

Having defined the objectives it next became necessary to decide upon the means for attaining them. From our original premises we came rather directly to the conclusion that the student's abilities should be directed into research on major problems. From this it followed logically that we must provide adequate facilities to carry out such research; that there must be a broad selection of fundamental courses to fit the student for his proposed research as well as to provide him with a broad perspective; that we must have graduate students with

* Condensed from two of the three papers presented under this title at the ASEE Annual Meeting in East Lansing, June 25–29, 1951.

ability and motivation commensurate to the task; and finally, that there should be opportunities for the type of faculty-student relationships necessary to carry such a graduate program to fruition. The remainder of our paper is an expansion on these points.

Coincident with the determination of a basic research policy we recognized that some sort of long-range planning was required. Establishment of a list of proposed research projects proved unsatisfactory, for what appeared to be a major project was sometimes revealed by susbsequent study to be premature or inadequately defined. We were headed in the direction of further contributions to the trivia with which the literature already abounds. This realization reoriented us away from the concept of neatly packaged thesis projects toward a scheme of basic programs having no predetermined duration and within which thesis work might be done as frequently and by as many students as the status of the programs from time to time should warrant.

Research Facilities

As some of our research programs began to develop it was apparent that we did not have adequate facilities for the work that we were embarking upon. We needed space where apparatus could be set up for the duration of a study, without interfering with our undergraduate laboratory work which was also expanding. We needed desk space for our graduate students at a time when there was insufficient office space for the staff. During this critical period the department augmented its permanent space to some extent, but mainly through an extensive study and re-allocation of existing facilities the space utilized by the Methods and Standards area was increased by 250% over the past five years.

Another sort of inadequacy in our facilities was equipment—particularly instrumentation. Actually, ours was about as good as would be found anywhere but the fact remained that the old standbys—the kymograph, marstochron, micromotion cameras, etc.—were obsolete for certain important types of studies. We were, and are increasingly dealing with multivariate phenomena. To generalize our findings with any degree of confidence it would be necessary to collect, in many cases, a rather respectable amount of data and subject them to extensive statistical analyses. The use of existing instruments for collecting these data would involve subsequently such an expenditure of clerical effort—such a waste of graduate talent—that we assigned a high priority to the development of modern instrumentation. Since modern instrumentation has become a specialized field in itself, it seemed uneconomical and even foolish that we should undertake this work ourselves. The problem was approached, therefore, by confining our efforts to the development of functional specifications which were then presented to electronics and instrumentation specialists in other Departments of the University. Thus, the Department of Electrical Engineering deserves major credit for the progress on some of our principal instrumentation projects.

A logical corollary to the instrumentation projects was the procurement of computing equipment to reduce the waste of talent in the clerical phases of data analysis. And along with these facilities we seemed to need another to reduce the time spent by students in organizing literature studies, collecting the material, and segregating from it that which was pertinent to their problem. Unfortunately, there was no service in this area corresponding to Psychological or Chemical Abstracts. The solution appeared to be a department abstract file for use of the staff and graduate students. Forms were designed and printed, and the file began to grow. Each student would check his study list against the file, using the abstracts to screen those titles which were listed. For all those not listed he went to the library and in the course of his study prepared abstracts which were in turn added to

the department file. Our original classification system, however, had been poorly conceived and soon became inadequate. Furthermore, we felt that mechanical sorting in addition to revised classification would greatly enhance the value of the file as a facility for graduate study. This work is now nearing completion.

Graduate Course Work

Thus far we have discussed a number of facilities which are important in our scheme of graduate work. To make effective use of these facilities in his individual studies, the student should be prepared through a program of course work tailored to fit his needs and abilities. To set up such programs there should be available a broad selection of fundamental courses. This requirement is satisfied in the large university, would be sometimes difficult to meet in the small college, and would practically never exist in the purely technical school. Some of our students, for example, take as many as 10 or 12 quarter hours in Experimental Psychology, others take a similar amount of course work in mathematical statistics beyond the calculus, or they may take minors in Economics, Physiology, etc. Another advantage of the University appears in the availability of top authorities in other fields to serve as special advisors on thesis research which has extensions into zones where we are admittedly far from being an authority. We have seen many instances where such on arrangement would have avoided a lamentable waste of research effort. Within our Department the descriptive approach has no place in the graduate level course. A student of graduate caliber does not require faculty assistance to digest descriptive material. The course work, therefore, is reserved for analyses of problems, dissection of contemporary methodologies and identification of the assumptions on which they are based, planning of investigations and analysis of results, study of research techniques and evaluation of research.

In short, the purpose of the course work is to mature the student intellectually, to construct a base from which he may continue to educate himself. In addition to an individually tailored plan of course work, the graduate student needs and is entitled to an opportunity for close contact with the faculty. The graduate program must be recognized as a process of developing the superior students and cannot be subjected to the administrative criteria for undergraduate teaching—such as, so many head per course-hour.

Our concept of an adequate graduate program, then, includes the establishment of fundamental research programs, the provision of facilities for the conduct thereof, a broad selection of graduate course offerings in the University, students with ability and motivation commensurate to the task (a point we have not detailed for lack of space), and an opportunity for close faculty-student relationships. The provision of these requisites is not merely a function of departmental staff endeavor, but of cooperation with other Departments and support of the Administration as well.

II. Graduate Work in Quality and Production Control

By LORING G. MITTEN

Instructor in Industrial Engineering, Ohio State University

This paper will concern itself with graduate work in the areas of Production Control and Quality Control in the Industrial Engineering Department of the Ohio State University. Particular emphasis will be given the relationship

between the graduate and the research programs in these areas. Two specific problems will be considered in detail:

1. The character of the field in which research is to be undertaken, and
2. The intellectual resources available for use in the research.

Meaningful research is not likely to spring solely from the "urge to research." Answers to the questions posed here are prerequisites to the design of specific research programs if fundamental contributions are desired.

Character of the Field

First, let us consider the character and degree of development of the field in which research is to be undertaken. On the one hand, there is Production Control which, from the basic research point of view, is almost totally undeveloped—it is a field which lacks fundamental unifying concepts and theories; a field abounding in rules-of-thumb, and in which practical experience substitutes for logical and rational method.

This situation offers great opportunity and at the same time a most difficult problem in research: opportunity because progress is possible in almost any direction: a problem because this same lack of an established basing point and direction gives rise to the necessity for really original and creative thinking.

Statistical Quality Control represents the opposite extreme. This subject is firmly grounded on well-validated basic theories and concepts, and its methods and techniques have been developed logically from these theories. Two choices faced us here: we could either concentrate our efforts on further elaboration of the basic theory and principles, or we could devote ourselves to the development and extension of practical techniques and methods from existing theory. We chose the latter alternative, and we now have a quite active group of research programs under way. For example, we have undertaken studies aimed at the development of new or simpler quality control techniques, at the introduction of economic considerations into quality control in a more explicit fashion, at extending the use of quality control techniques and the methods of mathematical statistics to new problems and new fields, etc.

The above discussion should serve to point out a basic fact: different fields of study have different characteristics and these characteristics impose definite conditions on the type of research which can be undertaken and the manner in which it must be carried out. We have had to recognize this fact in developing our Quality Control and Production Control research programs; the objectives and methods of execution of the programs have been tailored to the characteristics of the field in order to utilize our research potential to best advantage.

Intellectual Resources

We now turn to the second problem which arises in defining a research program—the question of available intellectual resources.

Probably the most important determinant of the type and caliber of research which can be undertaken is the capability of the departmental staff responsible for research work and graduate training. We have found that the greatest stimulant to creative and critical thought comes from assembling a staff with widely divergent backgrounds and training and giving them the opportunity to interchange ideas freely. To illustrate the benefits of this policy, let use briefly consider the course of development of one of our most significant accomplishments in Production Control—the formulation of a new theory of scheduling. A discussion of the inadequacies of present scheduling methods brought the problem to the attention of our staff mathematician. He formulated the problem in mathematical terms and was able to develop a solution to it. Later, as a result of discussions of this solution, another staff member was able to inter-

ject an economic criterion into the problem and thus further extend the utility of the results. The whole development was made possible only by the rather diverse abilities and viewpoints of our various staff members and by the free interchange of ideas among them.

Almost as important as the abilities of the departmental staff is the availability of expert, specialized knowledge outside the department. Any really worthwhile research program is almost certain to raise problems which cut across departmental lines and lead the researcher into fields somewhat foreign to his specialty. By far the most desirable solution to this problem involves consultation between the investigator and some individual who is thoroughly familiar with the specialized problem involved. There can be no question that the association of our department with a university employing top-ranking scholars in various fields is a distinct advantage in our research. For example, one of our Quality Control research programs involves an investigation of the factors affecting visual inspection performance. In the course of carrying out this investigation, we have consulted regularly with the chairman of the School of Optometry and with an expert in the Department of Psychology. Their aid has been of inestimable value in the successful execution of the project.

As the last factor in the problem of intellectual resources, we must consider the caliber and training of graduate students. The graduate student who contributes only physical and low level intellectual skills to a research program is being deprived of a vital part of his development and training, to say nothing of depriving the research program of the benefits of fresh approaches and individual abilities. If the student is to derive real value from the research phase of his studies, we must be sure that he has a proper background in the physical sciences, in engineering subjects, in mathematics, and in the social and life sciences.

Research in Industrial Engineering almost invariable involves a simultaneous consideration of physical and human problems. Machines are run by men; Production and Quality Control procedures are carried out by people and the procedures have a definite impact on those individuals responsible for the operations being controlled. If our research is to be meaningful, and if the results are to be of practical value, our graduate students must have a background which enables them to perceive and cope with the broad implications of the problems with which they are confronted. The so-called "broadening" subjects (such as psychology, physiology, sociology, etc.) are not merely desirable —they are absolutely essential; mathematical statistics and probability theory are musts; matrix theory gives promise of becoming a basic tool of great utility. We concede that no entering graduate student could be expected to be thoroughly conversant with all these fields, but we insist that he must have a firm foundation from which he can quickly build to the necessary proficiency.

The success of research is highly dependent on the intellectual capabilities of those planning, directing, and executing it. These capabilities must be honestly assessed and areas of strength and weakness delineated; the staff must be stimulated and their creative and critical abilities developed; strong ties must be forged with areas and individuals outside the department so that their expert knowledge can be brought to bear on problems; graduate students must have the proper background and training and their individual capacities must be used to the full. All this must be done consciously and vigorously if the graduate program is to yield significant research results.

Career Possibilities for the Teacher of Engineering Subjects*

By LOWELL O. STEWART

Professor, Head Civil Engineering, Iowa State College

The dictionary suggests that career may refer to a "profession or other calling demanding special preparation and undertaken as a life work." A poll of engineering teachers would, I think, elicit from many the statement that they just "happened to take up teaching." Few, if any, expected to make it a career. At one time I considered sending a questionnaire to engineering teachers to find out why and how they entered the field and how long they have been teaching. Returns from such a questionnaire would be interesting, they might have helped us to find a better answer to our question. We will have to be content with a qualitative rather than a quantitive study. Furthermore, I hope that this quick survey of the situation will stimulate discussion.

This brings us to the first point of our study: do the changing conditions in engineering make it necessary or desirable that we adopt a positive policy of selecting and preparing our engineering teachers of the future? These changing conditions may be summarized briefly as follows: For many years (in fact, prior to World War I) engineering was evolving from the art stage and there was heavy emphasis on empirical engineering practice. After World War I, and in particular since World War II, there has been increasing emphasis on the scientific aspect of engineering. We have reached a stage in that swing toward science where there are some who say that many of our engineering schools are now turning out applied mathematicians or applied physicists. A third stage in this evolutionary pattern is the increasing importance of science and technology in everyday life, and the growing number of engineers who reach executive positions where they are called to deal with important labor and industrial relations problems. Believing in the efficacy of course work we have set up courses in college where we propose to develop the student's ability to deal with and handle people.

The type of engineering teacher that we have needed and have called to our classrooms has paralleled the eras that I have described. When the emphasis was on the art and empirical aspect of engineering we needed men who had had a considerable amount of practical experience, men who knew and could teach how things were done in the field. Many of the older men on our staffs came into engineering teaching by way of this school of experience route.

Shifting Emphasis

As engineering practice moved from the art and empirical toward the exact science stage so did engineering teaching shift its attention. We began to hear more about research and graduate work Advanced degrees which had been a standard requirement for teachers in the arts and sciences for many years began

* Presented at Conference of Civil Engineering Teachers, ASEE Annual Meeting, East Lansing, Michigan, June 23, 1951.

to appear in engineering schools. The years since World War II have brought a large increase in the number of students who have earned advanced degrees in engineering. Some of this demand for more education was induced by the liberal provisions of the Veterans' Educational Programs. A substantial number entered graduate studies because they believed that the holder of an advanced degree in engineering would be able to find his way into types of work that were more profitable or more challenging than would be available to the holder of a bachelor's degree.

Presidents, deans, and department heads, sensing the changing educational picture in engineering, began to specify the master of science degree as a prerequisite, sometimes for appointment to any full-time teaching position, frequently as a requirement for advancement. It was a quick step from that stage to the present when we find that there is increasing demand that engineering teachers who wish to advance in rank and salary should have a Doctor's degree, frequently the Ph.D.

This demand that engineering teachers hold advanced degrees poses some important questions for the prospective teacher, for engineering education, and for the profession, and it bears directly on our subject, Career Possibilities for the Teacher of Engineering Subjects.

For the teacher there is the element of time and cost. To earn a master's degree requires approximately a calendar year and $1000 to $1500 cash outlay. The Ph.D. calls for three academic years of the candidate's time and several thousand dollars of his money. A popular way to work toward the advanced degree is to "learn as one earns" whereby the candidate teaches full-time or part-time while he carries on his graduate studies. Under such a program a full-time instructor might earn a master's degree in three years, and a doctor's degree in nine years. These periods could be shortened (at the expense of practical experience) if he attended summer school.

A quick consideration of the case of a typical young engineering graduate who is interested in a teaching career reveals that he should begin graduate work immediately after his baccalaureate degree. If he chooses to spend some time in gaining a few years of practical experience before he begins teaching he will face two strong factors that will deter him: one will be his salary and family responsibilities; the other will be the attitude of presidents and deans. He will find that his salary in industry has reached a level substantially above that which he will be offered in college teaching, and his family responsibilities preclude his accepting a cut. Presidents and deans with the best of intentions and desires to employ promising young engineers with experience will be unwilling to pay the salary that is needed, and they will seek men with advanced degrees.

This trend toward increasing emphasis on research and graduate study with advanced degrees as a prerequisite for engineering teaching, and decreasing attention to what we commonly call practical experience—the practicing of the profession—has important implications for engineering education and the engineering profession. As the courses of our engineering curriculums become more theoretical and "scientific," it follows that the professional engineers who learn from that course work will lean toward the "theoretical" rather than the "practical," resembling more and more the European engineers.

This swing away from the "practical" might go too far. Our engineering teachers must maintain more than a speaking contact with engineers on the job. They can have the advantages of advanced education without foregoing the benefits that come from "practical" experience. I suggest that this may be accomplished if the preparation of our engineering teachers includes: (a) summer work in industry, (b) consulting experience where possible, (c) sabbatical leaves for work in industry, (d) engineering registration, (e) active participation in techni-

cal societies, (f) some training in the techniques and business of teaching. The carrying out of the "work in industry" portion of this program will require the understanding and willing cooperation of many companies who employ engineers. This is not a new idea. It should be carried out on a larger scale than it is at present.

Educational Methodology

It is well known that college teachers have been uninterested, generally, in studying courses in educational methodology as a device for improving their own teaching. On the other hand, there are Educationists who would require college teachers to study several courses in Education, and qualify for a teaching position by certification. Teaching is an art and a profession. Surely there are principles and techniques of good teaching that can be taught, and need not be left for each teacher to discover for himself by trial and error. I think that every engineering teacher should have some effective instruction and direction in the principles and methods of good teaching. This may be done by taking course work, by observing good methods of experienced teachers, and by personal study. Perhaps it is true that good teachers are born, but it does not follow that good ones cannot be made.

Will this young man find a teaching position? We are entering a period of low college enrollments, a result of the low birth rate of the 1930's. However, the high birth rates of the early 1940's will bring a crop of high school graduates in the 1960's which will be considerably larger than the 1951 crop. From this increased number of high school graduates there should come more college students than we have in 1951, unless the American youths of that decade set values on a college education which are different from that given it in the past. We Americans have gone to college because it offered vocational or professional training with a good salary: because campus life is unique; it has some of the competitive aspects of life on the outside, yet it is idealized and controlled and protected so that the student does not pay heavily for his mistakes: and, because there is opportunity to satisfy intellectural curiosity. Perhaps some of the economic changes of this quarter century, which finds incomes of skilled workmen higher than that of college-educated men, may have some effect on college enrollment. However, the long-term trend toward college attendance by an increasing number of high school graduates is likely to go on, with continuing emphasis on science and technology. This, in turn, will call for more college teachers.

There will be enough opportunities so that, in general, well qualified engineering graduates will experience little difficulty in finding a teaching position. There is real danger, however, that too few of the able young men who are needed will see the desirability of making a career of engineering teaching. Many engineering colleges have had difficulty in recruiting the type of man they would like to place in teaching positions.

Rewards of Teaching

It is pertinent at this point to consider the rewards of teaching and the qualities of a good teacher; to explain what seems to be a paradox, namely, that teaching is one of the medium salaried arts and professions, yet it calls for men with high abilities and strong personal traits. Some wag has said that "those who can, do; those who cannot, teach." That is a slanderous statement which expresses the opinion of many poorly informed people. The truth is that the teacher, at all levels of instruction, carries a heavy responsibility. He is expected to be expert in many subjects particularly in his major field of specialty; he must be a good citizen, a good example for other citizens; he should have no vices; it is presumed that he will be able to teach all types of students effectively;

many students and parents look to him for all kinds of counsel and advice in technical, professional and personal matters.

Yet the teacher does receive a lower salary than his equally able classmates who make their careers in industry. Each year most of the ablest men of the graduating class take engineering jobs. Perhaps they have had enough of college life and wish to go out to make their way as they had planned. Possibly, there are instances where students gained the impression from their teachers that teaching would not be a desirable career. Maybe the difference in salary is a measure of the risks involved, the thought being that the man in industry faces a greater probability of losing his job or of taking a cut in salary than does his classmate on an engineering college faculty.

What are the great rewards of teaching? We will name three important ones. There are others. The teacher has leisure; he is using his mind on valuable subjects; and, he has the satisfaction that comes from making something.

Leisure according to the dictionary means "freedom afforded by exemption from occupation or business; time free from employment." Some one in a facetious or misanthropic mood after a particularly frustrating day of wrong answers or poor reports might question the soundness of our assumption that the teacher has leisure. This person forgets, perhaps does not know, that anyone in any field of work has his moments of discouragement and feeling of overwork. The fact is that the typical teacher of engineering subjects, who knows how to plan his work, has many hours when he can do interesting and exciting things (as long as he remains a teacher and does not move over into the area of administration). He can write books and technical articles; he can carry on research projects; he can accept assignments to help on committees of technical and professional societies; he can do consulting work on challenging problems in his field; he can accept election, on public and semi-public boards; he can spend profitable moments counseling students and pleasant hours reminiscing with alumni; he can take interesting, useful, and restful vacations. Other people do these things too, but the teacher has a flexible time schedule which does not call for an eight to twelve and one to five o'clock daily appearance on the job. During these periods when he has no daily chores he can use his time as he chooses; and that is leisure.

The teacher is using his mind on valuable subjects. Whether a given subject is valuable may bring difference of opinion and debate. Yet the matters that are the daily tasks of the teacher have become established as important by common consent. He studies and teaches the works of the great mathematicians, physicists and chemists and applies their principles to the solution of current problems. He learns the fascinating story of the development of engineering from simple observed happenings to the present-day body of knowledge. These studies help to introduce him to the newer discoveries that have come after Einstein and most recently nuclear fission. And there are the great works in the humanities and the social sciences as well as the new ones that appear daily. All of this he does as a part of his daily job. Is there any doubt that he uses his mind on valuable subjects?

The third reward was the satisfaction that comes from making something. Again we can point out that many people make something from which they gain satisfaction. The teacher's reward is akin to that of parents as they watch young people develop under their guidance. Every teacher has experienced the joy of seeing a young person grow under guidance from a rough, untrained but eager youngster into a smooth, careful thinking and effective man or woman. And several years after graduation when they return as successful engineers to tell about their work, often times bringing

their families, the teacher has his supreme reward.

Qualities of Good Teachers

This is a good place to mention the qualities of a good teacher because there are only limited career possibilities in teaching for the young man who does not have them. The teacher must know his subject. If he is to do better than "just keep ahead of his students" he must understand the rudiments of his subject thoroughly. To do this he should know the subject in its higher or advanced levels. That's one of the good reasons why a young teacher should pursue graduate work and research. Young people have an infinite capacity for asking questions and the teacher who is not prepared to answer questions in the ranges above the current work level will not do a complete job.

The teacher should like teaching, although there might be some minor details that he dislikes. He must have the will and patience to prepare himself thoroughly in some subject matter fields that are close to his. He should enjoy the daily business of lecturing; leading discussions; asking thought-provoking questions, written and oral; preparing problems and examinations, and correcting them after they are written.

It follows that he must like students and enjoy their company, both the good ones and the bad ones, and he must keep the relationship impersonal. He should believe in the basic goodness and worth of the individual. He cannot force his students to learn. Teaching and learning call for mutual confidence and respect. There aren't many instances where there has been learning in an atmosphere of mutual dislike.

There are several desirable personal traits: the teacher should have a sense of humor; he should have a good memory; will power and self control; a kindly and friendly manner.

Before closing this list of teacher traits I wish to mention something that has worried me a good deal recently. It seems to me that young teachers are reluctant to do a bit more than they are paid for. Is this just a figment of my imagination? If true it must be another sign of a point of view which seems to say that we can have something for nothing. But teachers, above all, should be exponents of a sterner philosophy. This ideal of the true professional man is well described by the late William E. Wickenden in his paper, "The Second Mile," * in which he takes as his text from The Sermon on the Mount, "Whosoever shall compel thee to go one mile—go with him twain."

The Dollar Problem

There are some factors that are not entirely favorable to the proposition of a greatly expanding teaching staff. Educational costs have been rising along with other costs. Publicly supported institutions of higher education find themselves competing for the tax dollar with a number of lustily growing newcomers. For example, the Iowa legislature appropriated for 1951–52 very nearly as much money for Social Welfore (Aid to the Blind, Aid to Dependent Children, Child Welfare, Emergency Relief, Old Age Assistance—by far the largest of this group) as it did for higher education. Moreover, these social welfare requirements will increase each year. Taxpayers are becoming tax conscious but they are not well or adequately informed about the uses of their tax dollar. Higher education could lose in the race for its needed share of that dollar.

The income situation for privately supported colleges and universities is more precarious than that of the state schools. Fixed incomes from endowments are falling behind needs as the purchasing power of the dollar falls. Furthermore, income taxes are taking for the government large sums that used to be available for gifts and endowments. So these schools, like the state schools, are hard pressed

* *A Professional Guide for Junior Engineers,* ECPD, p. 44.

to find enough money to pay high-enough salaries to as many teachers as they need.

Another factor that may affect the share of the budget that will be available for teaching is the rapidly increasing amounts of money that are spent on research. This should have no depressing effect on the total employment of engineering graduates because those who do not teach could do research. A conflict for funds between teaching and research may arise in about ten years when the high school graduates of the 1960's enter college.

A third factor in the apportionment of the educational budget is the increase in administrative costs. Some of this comes from increased services to the students, such as counseling, personnel and employment departments, testing bureaus, and others Some of it is spent for assistant deans and other administrative assistants and for stenographic help for these assistants. Looking at this matter from the standpoint of employment opportunities for engineering graduates in the educational field one might say that it is on the "plus" side. But it does reduce the portion of the budget that is available for teaching.

Generally, unit costs in education have been rising steadily. Teaching loads (student contact hours or similar units) are smaller than they were a few years ago. Class sizes increased during the recent heavy enrollment period but they are returning to normal now. Some schools are operating on a five-day week (no Saturday classes). There is less committee work and other extra-curricular assignments for the teachers (assistant deans do some of this). All of this is favorable from the selfish point of view of the individual teacher. But it may be unfavorable in the overall effect if costs become so high that money cannot be found to carry on at that level of operations.

Recent developments, hastened by tensions of the war years, have brought into sharp focus a matter that has had little attention from teachers of engineering. I refer to academic freedom and tenure. In some states public employees, including teachers, have been required to sign oaths, commonly designated Loyalty Oaths. In the main, teachers of engineering have shied away from any connection with the American Association of University Professors who have carried the burden of the fight to maintain academic freedom and tenure for the teacher. This is truly a matter of fundamental importance because they are the principles that guard our freedom as citizens. Institutions of higher education are conducted for the common good and the common good depends upon the free search for truth and its free exposition. Teachers of engineering and of science have assumed that they deal in facts, and facts are not controversial. Yet we have seen governments and states set up an official and, therefore, a so-called true and correct set of facts.

In summary, we have pointed out that teaching offers significant rewards to those who have the qualities of a good teacher; that there is increasing demand that teachers hold advanced degrees which implies stronger emphasis on science and theory; that this calls for stronger efforts of the teacher to acquire knowledge of engineering practice; that there seems to be a need for a defined program for recruiting and training teachers of engineering; that there will usually be places for competent engineering teachers; that college enrollments will increase in the 1960's which will require more teachers than we have now; that increased educational costs and competing requests for the taxpayer's dollar leave smaller amounts for educational purposes.

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
*Allegheny	Carnegie Institute		E. B. Stavely, Pennsylvania State College
Illinois-Indiana	University of Illinois	May 17, 1952	D. G. Ryan, University of Illinois
Kansas-Nebraska	University of Nebraska	Nov. 16–17, 1951	Kenneth Rose, University of Kansas
Michigan	University of Detroit	May 10, 1952	W. P. Godfrey, University of Detroit
Middle Atlantic	Newark College of Engineering	December, 1951	S. J. Tracy, Jr., City College of New York
Missouri	University of Arkansas	April 5, 1952	R. Z. Williams, Missouri School of Mines
National Capital Area	Howard University George Washington University	February 5, 1952	W. Oncken, Jr., Bureau of Ordnance
*New England		May 10, 1952	E. T. Donovan, University of New Hampshire
*North Midwest			S. J. Chamberlin, Iowa State College
*Ohio	Ohio State University		W. F. Brown, University of Toledo
*Pacific Northwest	Seattle		T. H. Campbell, University of Washington
*Pacific Southwest	Los Angeles San Francisco	April, 1952	S. F. Duncan, University of Southern California
*Rocky Mountain	University of Wyoming		E. J. Lindahl, University of Wyoming
Southeastern	Clemson College	April 10, 11, 12, 1952.	R. L. Sumwalt, University of South Carolina
Southwestern	University of Houston	April 11 & 12, 1952	H. P. Adams, Oklahoma A. & M. College
*Upper New York	Clarkson College		W. H. Allison, Clarkson College

Members of the Society are welcome at all Section Meetings

* No Date Set.

The Non-Engineer Looks at Engineering Students*

By A. M. BUCHAN

Professor of English, Washington University

The topic of this talk is not one of my own choosing. It was assigned by your committee. Dean Stout may have chosen it, knowing that one of my chief interests for a number of years has been a desire to make literature palatable and useful to young engineers. It has not been a very grateful task, because the notion still persists that it cannot be done. Unfortunately, too, the heads of English departments, vain of scholarship only, often assign to the engineers the duller members of their staff, and, if the teacher is dull, not even literature can be made exciting.

The distinction, however, in the title, between the engineer and the non-engineer is one that leaves me unhappy and unpersuaded. There is an old Scottish proverb that says, "We are a' Jock Thomson's bairns," and it is to the children of Jock Thomson, human children very much alike in moods and aspirations, that we direct our education, including that part of it which has to do with spiritual and personal security. Engineer and non-engineer find in literature, and perhaps in literature only, the kind of training in idea and mood that gives meaning to the techniques as well as to the arts.

In fact, as I recall my friends who are engineers, they are not markedly different from myself and my literary acquaintances. They are quite at home conversing with educators or physicians or lawyers or business-men about affairs in Iran or Korea. They work, during some part of their leisure, on the same community problems, being concerned about the kind of school or church or swimming-pool their children frequent. They are interested, within and beyond their specialties, in similar topics, debating the relative merits of a Buick or an Oldsmobile, an apartment or a house in the country, a vacation in Colorado or in Maine. In their personal lives they pursue the same goals, a desire for respect and independence, and a hope that courage will endure if security fails.

Even in the world of social appearances, the effort to segregate the engineer from the non-engineer implies a distinction that is almost half a century behind the times. Long ago the engineer graduated from the overalls and rough high boots of the surveyor's helper. He wears the white collar of his profession, and, in practical affairs, he teams up with the economist, the architect, the social worker, the advertising man, even the clergyman. To some extent, he assumes his share of the responsibility of each one of these, and, while the details of his contribution to society differ from theirs, they and he require something of the same training and the same kind of manhood.

And, just as the gap has been bridged between the old rough engineer and the more polished member of the older professions, so the distinction between engi-

* Presented before the Missouri Section of the ASEE, University of Missouri, April 7, 1951.

neering students and other students in the college or the law school or the school of business seems to be disappearing. When some of us started teaching twenty-five years ago, we had a general impression that the boy who elected engineering was a rather different breed of animal from the usual college boy. On the surface he did not display the same superficial gloss. His clothes were often untidy, and his manners were deliberately rougher and a little uncouth. He scorned some of the light-hearted gaiety of the campus, because he was pledged to more serious and masculine pursuits. But that engineering student of some time ago—and he was a likable lad, in spite of being consciously a diamond in the rough—is not very common any more. In general, the student of engineering is no longer, if ever he was, essentially different from any other liberal or professional student. There comes into schools of engineering a representative selection, I believe, of the student population of the country.

Intellectual Categories

When in the fashion of the pedagogue, I divide my students into categories, I place them in three simple groups. There are, first, the brilliant ones whose abilities we admire and envy. They come, for the most part, from good homes and good high schools. Having been accustomed at home to hear literate talk and to read wisely, they adjust to courses in speech and composition and literature as naturally as to math and chemistry. They are blessed with the greatest gift of the college student, a fine abstract intelligence, and they find little trouble in any branch of study. With their kind of intellectual equipment, they discover that the applied courses of their junior and senior years in engineering school are almost elementary once the theoretical foundations have been laid in math and physics and chemistry. In medicine or law, in English or thermodynamics, this type of student excels.

Theoretically, it is almost impossible to overwork the brilliant student. His capacity to assimilate and to use information is tremendous, and his instructors, suspecting this, load more and more technical courses on him during his later years in school. My own personal judgment, as a teacher of literature, questions the justice and wisdom of such a policy. For this kind of young man stands to profit far more than the average person, at this stage of training, from the leisure that his active intelligence has earned for him. As a junior and senior he should have the option within the curriculum of reading widely in history and economics, even of acquiring another language if he prefers, so that the required professional courses will merge, as his professional work will, later in life, into a wide personal and social context. He should have a chance to read and to discuss whatever finer issues appeal to him, and he should have on hand as his guides teachers who remember that a profession is only as great as the personalities of the people who man it.

The second group of students, the mass of low B's and C's, has considerably more of a handicap. Many come from homes where magazines substitute for books and in which conversation is casual and slovenly. The broad fields of history and literature and the basic sciences have been covered at breakneck speed in high school so that very little of their significance stays in the memory. It is often an almost completely fallow mind that these average boys bring to college, clumps of weedy interest appearing in a wide expanse of boredom. Their classes in math and physics, though they begin on an incredibly elementary level, keep them very busy, and classwork in the humanities seems an unnecessary intrusion on precious study hours.

It is only being realistic to concede that these slower students have an argument against too much classwork in the humanities. Immersed in calculus which they must learn, they resent Somerset Maugham's *Of Human Bondage* which is only a single option among a thousand. Perhaps part of an answer is the one we

have tried in Washington University of substituting infrequent conferences for regular class sessions, and an optional for a required reading-list. A program of this sort, added to the obligatory training in speech and composition, is a frank recognition of an aim—that it is better to have a student continue to like reading than to cram a mass of distasteful books down his throat.

At the bottom of the college heap is a third group, a number of stupid and sometimes friendly lads for whom not a great deal can ever be done. They lack the range of intelligence that makes possible an outlook broader than the immediate task. The profession of medicine has for some time been rejecting such lads by a variety of screening processes, and they are beginning to find themselves excluded from schools of law. In the college and the school of engineering we still put up with a few of them, hoping for a miracle. But our hope usually stops short of a diploma, and we waste time and prejudice the standards of the profession by setting the hope too high.

This division of students has no particular value except to sharpen my point that the engineering school, like the college or the business school, enrolls a number of the three kinds. We who teach English have had students of engineering who were perfectly at home in advanced courses in literature, whose minds were philosophic as well as pragmatic, who were broad-gauge young men as well as expert technicians. We have also taught, in the college of liberal arts, young men and women who would be as helpless in the presence of a centrifuge as they are in the company of a simple sentence.

Distinctive Characteristics

It may be possible, however, to suggest one or two areas in which the engineering student does appear to have a mark of difference. His distinguishing qualities are almost certainly indications of different interest rather than of different capacity, and they are mentioned because they seem to point in the direction towards which the study of language and literature should move in technical education.

1. The engineering student is less inclined to "verbalize," i.e., to put his ideas into words, than the college student. Used to the precise terminology of mathematics and the sciences, he shies away from words that are vague and indefinite. He can define a cosine, he is not so positive about a lyric. He knows what ought to be written about an experiment in chemistry, but he doubts whether it is worth while to give his impressions of a novel or a character in history.

Perhaps he unconsciously believes that some impressions are to be felt and not put into words, that they are obvious and do not need words. He may even suspect that the abstract vocabulary of the social and humane studies muddles rather than clarifies the mind, and in this suspicion he may be justified. Somehow, though, he must learn that much of human relationship is carried on, and must be carried on, by means of words and phrases that are not precise like the symbols of science. When he goes into the world out of the lab, he needs some facility in the hit-or-miss communication of ideas, and his speech and writing must be disciplined to meet this need. He must learn, that is to say, to communicate, in his social and personal life, by words, as well as in his technical life, by graphs and statistics. These fashions of communication are, of course, the basic substance of our courses in English.

2. Linked with this reluctance to verbalize is a happy circumstance about the technical student—and about mature engineers, too—a refusal to accept some ideas at their face value. Among the ideas he is inclined to reject are some that appeal strongly to the teacher of literature. The man of letters usually prefers his mental cocktail flavored with a dash of mysticism, and his eye is more attuned to the nuance than to the trim outline. In a sophomore college class, the young English instructor becomes excited about wandering lonely as a cloud and admiring

a host of daffodils. His engineering student is as apt as not to feel slightly nauseated under these circumstances.

The difficulty does not lie with poetry itself or with an incapacity in the student to admire daffodils singly or in quantities on a field. Engineers, as I know them intimately, are not at all less sensitive than teachers of literature to the beauty of a flower or a sunset or a human face. Many of them are camera experts and take a natural delight in color and form and the beauties of old association. But they are slow to read into a field of daffodils or any other scene the mystical philosophy of a Wordsworth or a Thoreau. They look for more immediate and more practical values.

This pragmatic approach to ideas is, in some ways, of high critical importance. It has the merit of rooting an idea in the facts of one's own experience. A student of mine, for instance, a veteran, became interested, through his course in reading, in the psychology of Alfred Adler and the now familiar notion of the significance of inferiority attitudes during the early stages in life. He began his report by outlining the Adlerian theories and then suddenly branched off into a discussion of his own two children, aged five and two. He explained how they had been parked on their grandmother and were beginning to show the symptoms that Adler described of the neglected and insecure child. As he spoke, his analysis of Adler became a scrutiny of his own family problem, and from a book on psychology he took guidance towards the important decision to set up housekeeping again for the sake of his children.

3. The engineering student, then, is restive in the presence of ideas as such and seeks some practical application of them. He takes a similar attitude towards his own career. Quite early and usually in complete sincerity, he directs himself towards a practical goal. He is aware that an engineer makes a good living and has a substantial place in his community. So, as a young man, he concentrates much of his effort on practical lines of ambition, and other needs, less obviously useful and immediate, have to be justified in his eyes.

Doubting Thomas

So that we who are responsible for the humanities must be perfectly candid in our teaching. Though we are convinced of the worth of history and literature and economics, the student of engineering may not agree with us unless and until we are prepared to prove our case. Our specialties seem to him to be unessential, icing and not cake, decoration and not structure. If we are to make them acceptable, we must spend part at least of our inadequate teaching time trying to show why some books are worth reading and how the record of the past helps to make the present understandable. In an engineering college we are not teaching students who will take what they are given so as to regurgitate it, grade-wise, in examinations. The engineering student is a professional doubting Thomas asking for proof of a miracle.

These marks of difference in him—his reticence, his practicality, his drive towards a manageable goal—would not be worth mentioning if his education were merely a training for a job. His refusal to be sidetracked, in fact, could easily be a guarantee of his future success. But few teachers of engineers would be willing to interpret education so narrowly. There is another world for engineering students besides that of practical aims. Within him resides the life of his mind and spirit. Around him revolves the similar life of his friends, the life of human contacts.

At this point, it is necessary to part company with the students, and to speak rather of those who are now engineers and teachers of engineers. For only to the extent that engineers, men engaged in the teaching and practice of the techniques, prize this personal life and this life within the community will any measure of its importance be reflected among the young men who are still being taught.

A hint comes to me, now and then, of the technical man's attitude. A common friend introduces me to an engineer. After the names are given, the engineer asks, "And what is your line?" "I teach English," I reply. Invariably—and it has happened so often as to be amusing—the engineer remarks with a smile, "Oh, oh! I'd better watch my grammar," or "It's years since I read *Hamlet*. Do you still read it in school?"

Such a remark may seem trivial but it reveals a great deal about the speaker. Uttered as it is, smilingly, it is half an apology and half a gesture of defiance. On the one hand, it asks humble forgiveness, as from a school marm, for a split infinitive which is not important. It suggests regret for books that have not been read and for ideas that no longer occupy or interest the mind. At the same time, it implies that the literature and ideas, to which the teacher of the humanities devotes himself, are not of much significance to active, energetic men.

Cultural Deprivation

The note of defiance, I believe, can be overlooked. Every one of us, denied the chance of doing more than one thing reasonably well, is inclined to resent the different competence of a neighbor. But the engineer's tone of deference is another and a stranger omen. In remarks like the ones quoted, he is paying tribute to areas of education, the practice and enjoyment of which have been denied him by the narrow scope of the engineering curriculum. If we wished to be psychological about it, we'd say that the engineer suffers from a feeling of guilt or inadequacy. Friendship with a teacher of humanities—I'm dreadfully sorry that it should be so—makes him acutely aware, not of his advantages only because these are obvious, but of his shortcomings.

What is it that my friends who are engineers imagine they have missed along the way of their training? Put simply, it is a wider and deeper familiarity with literature, the arts, and the nebulous fabric known as culture. They wish there could have been more leisure for music, painting, and the reading of non-technical books. Some of them even hanker after the minor fruits of culture, an easy manner among people, a fluent tongue when the conversation turns to politics and social affairs. Almost every one gives evidence of his regret that valuable opinions and attitudes and ideas were denied him in the course of his training. He has been kept from a heritage which is rightfully his as a professional man.

Let me confess that few of my engineering friends are satisfied with their deprivation. One devotes himself to music and allays his sense of guilt, as the psychiatrists say, in trying to master the piano. One gives a great deal of his leisure, of which he has little, to the affairs of the local school in which his children are pupils. One allows his wife to serve as a substitute teacher at the expense of her housekeeping and the promptness of his evening meal. Others take every opportunity to drop in on those of us who have leisure to read, so that they can participate in the give-and-take of intelligent talk. Alongside the technical magazines that come home from the office and the sheets of specifications that come from the job is a stack of "Harper's" on the engineer's library table or a modern novel that he hopes he can find time to read some day.

This desire to compensate, this hunger for they know not what in the way of personal cultivation, is the reason for my friendship with engineers and for my belief that their training should contain large elements of the humanities. The student of engineering should be given as generous an opportunity as the curriculum affords to know and like literature, and to be encouraged to speak freely about ideas. He should not leave college with a grudge against it for never having opened to him a whole wide range of social and personal values. In some

degree he should always have a sense of inadequacy, since it will keep him hungry for what is still to be known, but he deserves some guidance and stimulation in the great impracticalities of living.

He may not be able to read many books but he can be given so as to retain it the capacity to enjoy a novel or a play. He should be encouraged to find excitement in a world of ideas not directly related to any occupation, and even in things too imaginary to be realized. Somewhere in his training, too, he ought to learn that one way to keep his interest in people and society awake is to try to express this interest in words and stories.

He may learn, also, that a sensitiveness to literature and art is nothing to be ashamed of. His reticence is, in some respects, a virtue, saving him from the sheer gush of the college sophomore. But an emotion that is never expressed may dry up completely, and an idea that is not discussed may lose its charm. The personality of the student—this is an element in his education, and engineer and non-engineer alike have a stake in its development.

Sections and Branches

Report on North-Midwest Section Meeting of American Society for Engineering Education

Eighteen technical papers and reports held the interest of some 200 members of the **North-Midwest Section** at their annual meeting at the University of Wisconsin, October 5 and 6.

Professor Olaf A. Hougen, Chairman of the Department of Chemical Engineering at Wisconsin, who recently returned from a year's service as a Fulbright scholar in Norway, where he taught at the Trondheim Technical School, was the main speaker at the annual dinner on October 5. He gave an illustrated talk on his extensive travels in Norway. Other speakers at the dinner included Dean Morton O. Withey, toastmaster, and Dr. Ira L. Baldwin, vice-president of academic affairs at Wisconsin.

In addition to the various divisional meetings on Saturday, October 6, Professor L. O. Stewart, Iowa State College, lead a general session on society affairs. This innovation was well received by the members.

Elected to serve as officers for next year are:

Chairman: S. J. Chamberlin,
Vice-Chairman: A. B. Drought,
Secretary-Treasurer: Wm. C. Alsmeyer,
Council Representative: Kurt F. Wendt.

TIMELY TIPS

Some Remarks on Envelopes

By H. W. BRINKMANN and R. A. ROSENBAUM

Professors of Mathematics, Swarthmore College

The following problem, which arose in a class in descriptive geometry, leads into questions which may have some pedagogical interest: If a flaring surface, like an old-fashioned phonograph horn or (with rather different dimensions) a modernistic lamp-shade, is generated by revolving the arc, AB, of a plane curve about an axis in the plane of the curve, what are the orthogonal projections of the surface? The projection on a plane, π, for example, is simple if the axis of revolution of the surface is either parallel to π or perpendicular to π, but how does one determine the so-called "curve of visibility" of the surface for other orientations of the axis?

If π is vertical, if the phonograph horn is placed with its axis vertical and with the small end below the large, and if the axis is then tipped back, say $\theta°$, $0 < \theta < 90$, in a vertical plane perpendicular to π, it is intuitively clear that the curve of visibility, C, will start somewhere on the ellipse which is the projection of the circle generated by A and may end before it reaches the ellipse which is the projection of the circle generated by B. In fact, C is at least part of the envelope of the family, F, of ellipses which are the projections of the circular sections of the surface, and the phenomenon described in the preceding sentence is related to the fact that not all members of F necessarily have real contact with the envelope.

Envelopes of Families of Curves

Examples of families of curves not all members of which have real contact with the envelope of the family are considered in standard text-books—on differential equations, among others. For instance, the envelope of the family of circles,

$$f(x,y,\alpha) \equiv (x-\alpha)^2+y^2+\alpha^2-k^2=0,$$

is the ellipse

$$\frac{x^2}{2k^2}+\frac{y^2}{k^2}=1.$$

Here there are real circles of the family for $|\alpha| \leqslant k$, but the circles for $|\alpha| > \frac{1}{\sqrt{2}}k$ do not have real points of tangency with the ellipse.

The following three-dimensional picturization may often be helpful to the student and may be especially useful in helping him to visualize the situation outlined in the above example.

If the surface $f(x,y,z) = 0$ has a "projecting cylinder," $F(x,y) = 0$ (i.e., a cylinder with an axis parallel to the z-axis enveloping the given surface), then the curve $F(x,y) = 0$, in the xy-plane, is the envelope of the family of curves $f(x,y,\alpha) = 0$. (The curve of visibility, to go back to the terminology of section 1, is part of the envelope of a family of contour lines.) Furthermore, if there are real sections of the surface $f(x,y,z) = 0$ for $z_1 \leqslant z \leqslant z_2$, while all real points of tangency of the cylinder, $F(x,y) = 0$, with $f(x,y,z) = 0$ are included in the range $z_1' \leqslant z \leqslant z_2'$, where $z_1 < z_1'$, or $z_2' < z_2$, or both, then there will be curves of $f(x,y,\alpha) = 0$ which do not have real contact with the envelope.

In the example with which this section was begun,

$$f(x,y,z) \equiv (x-z)^2+y^2+z^2-k^2=0$$

is an ellipsoid so oriented that horizontal sections of the surface are circles. It is easily seen that z is limited to the interval $[-k,k]$. The projecting cylinder has an elliptical cross-section; points of tangency with the ellipsoid are restricted to the range $-\frac{1}{\sqrt{2}}k \leqslant z \leqslant \frac{1}{\sqrt{2}}k$. For $-k \leqslant z < -\frac{1}{\sqrt{2}}k$, and for $\frac{1}{\sqrt{2}}k < z \leqslant k$, the circular sections of the ellipsoid all lie within the projecting cylinder.

Example

We return now to the problem of section 1. Suppose, as an example, that the phonograph horn is generated by revolving about the vertical y-axis the arc of the curve $ky = x^{2/3}$ from $y = a$ to $y = b$. If the surface is tipped straight back $\theta°$, $0 < \theta < 90$, the circular sections of the surface will project onto the frontal plane π as ellipses. The circular sections at a distance p above the origin will have a radius of $(kp)^{3/2}$; hence, the equation of the family of ellipses will be

$$f(x,y,p) \equiv \frac{x^2}{k^3p^3} + \frac{(y - p\cos\theta)^2}{k^3p^3\sin^2\theta} - 1 = 0. \quad (1)$$

Differentiating with respect to p, in order to obtain the envelope, gives

$$f_2(x,y,p) \equiv 2(y - p\cos\theta)\cos\theta + 3k^3\sin^2\theta \cdot p^2 = 0. \quad (2)$$

Equations (1) and (2) are parametric equations of the envelope, with p as the parameter; when they are solved for x^2 and y we have

$$x^2 = k^3p^3 - \frac{9}{4}k^6\tan^2\theta \cdot p^4,$$

$$y = \cos\theta \cdot p - \frac{3}{2}k^3\sin\theta\tan\theta \cdot p^2.$$

It is found that, for $p = 0$, $\frac{dx}{dp} = 0$, $\frac{dy}{dp} \neq 0$; and, for $p = \frac{1}{3k^3}\operatorname{ctn}^2\theta$, both $\frac{dx}{dp}$ and $\frac{dy}{dp}$ are zero. The shape of the envelope is approximately that of the accompanying figure, where 0 corresponds

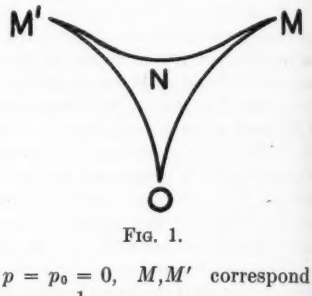

FIG. 1.

to $p = p_0 = 0$, M,M' correspond to $p = p_m = \frac{1}{3k^3}\operatorname{ctn}^2\theta$, and N corresponds to $p = p_n = \frac{4}{9k^3}\operatorname{ctn}^2\theta$. If $a < p_n < p_n < b$, then we have the curve of visibility for $a \leqslant p \leqslant p_m$, there are points of tangency, hidden unless the surface is transparent, for $p_m < p \leqslant p_n$, and no real tangency of the ellipses with the envelope for $p_n < p \leqslant b$. The critical value, p_n, has a simple interpretation in terms of the original generating curve, $ky = x^{2/3}$. For this curve,

$$\tan\phi = \frac{dy}{dx} = \frac{2}{3kx^{1/3}} = \frac{2}{3k^{3/2}y^{1/2}} = \frac{2}{3k^{3/2}p^{1/2}},$$

or $p = \frac{4}{9k^3}\operatorname{ctn}^2\phi$. A comparison of this with the expression for p_n shows that real contact of ellipses with the envelope occurs only for those members of the family generated by points on the original curve where the inclination is not less than θ, the angle of tipping.

TIMELY TIPS

Comparison of Thermal Efficiencies of Rankine and Regenerative Steam Power Cycles

By SEYMOUR COMASSAR

Lieutenant, USNR, Department of Marine Engineering, United States Naval Academy

Abstract: A simple proof to show that an ideal regenerative steam power cycle must have a greater thermal efficiency than an ideal Rankine steam power cycle operating between the same pressure and temperature limits is described.

Prior to the study of the regenerative cycle, it is usually brought out that in comparing a reheat steam cycle with a simple Rankine cycle operating between the same pressure and temperature limits, the reheat cycle produces a greater work output but also requires a larger heat supply. Under these conditions, the thermal efficiency of the reheat cycle may be greater than, equal to, or less than the thermal efficiency of the Rankine cycle, depending upon the reheat pressure and temperature selected.

In comparing an ideal regenerative cycle with a Rankine cycle operating between the same pressure and temperature limits and with the same weight rate of flow to the condensers, the regenerative cycle also produces a greater work output and requires a larger heat supply. The fact that the thermal efficiency of the regenerative cycle must always be greater than the Rankine cycle under these conditions is not always obvious

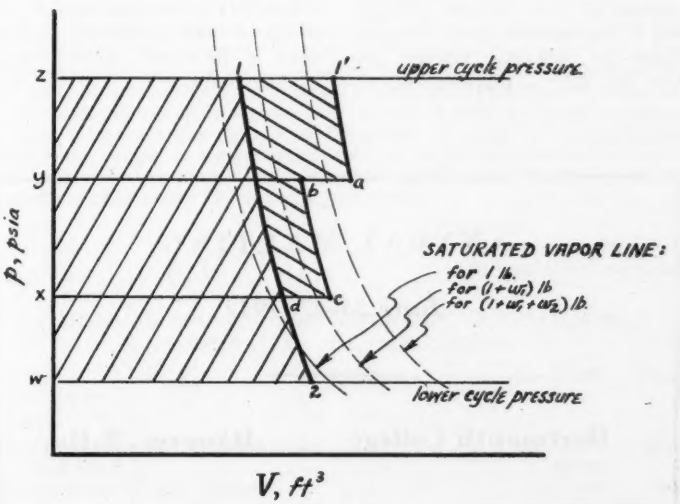

FIG. 1.

to the student, especially on the basis of the prior comparison of the reheat and Rankine cycles. A proof of this fact follows.

Compare the regenerative and Rankine cycles on the basis of the same pressure and temperature limits and *equal flow rates to (and through) the condensers.* Therefore the specific values of the properties of the steam in both cycles will be the same at the turbine inlet and exhaust and at the condenser inlet and discharge. The weight rate of flow to the regenerative cycle turbine will be greater and therefore its work output will be larger than the Rankine cycle turbine. The heat rejected to the condenser circulating water in both cycles will be equal. If all pump work in both cycles is neglected for simplicity (pump work is not equal in the two cycles but the difference is negligible) the work output of the turbines is equal to the net work of the cycles and these work quantities can be shown as areas on p-V coordinates as in Fig. 1.

In this figure, line 1–2 represents the isentropic expansion in the turbine of the Rankine cycle and the area 1-2-*w*-*z* is the work output of this turbine ($\int_1^2 V dp$). Utilizing a regenerative cycle with two extractions for feedwater heating, the lines 1′-*a*, *b*-*c*, and *d*-2 represent the expansion of steam in the turbine of this cycle with different weight rates of flow due to the extractions. The work output of this cycle is the sum of the areas 1′-*a*-*y*-*z*, *b*-*c*-*x*-*y*, and *d*-2-*w*-*x*, or 1′-*a*-*b*-*c*-*d*-2-*w*-*z*.

Let W equal area 1-2-*w*-*z* and ΔW equal area 1′-*a*-*b*-*c*-*d*-1. Therefore the work output of the Rankine cycle is W and the work output of the regenerative cycle is $W + \Delta W$.

Thermal efficiency of a cycle is defined as Wk/Q_s. Since $Q_s = Wk + Q_r$, the thermal efficiency can be expressed as $Wk/(Wk + Q_r)$; where

Wk = net work output of cycle,
Q_s = heat supplied to cycle,
Q_r = heat rejected from cycle.

On the basis of the areas on the p-V diagram above, the thermal efficiency of the Rankine cycle is $W/(W + Q_r)$ and the thermal efficiency of the regenerative cycle is $(W + \Delta W)/[(W + \Delta W) + Q_r]$. Since Q_r is equal in both cycles, the latter thermal efficiency value is necessarily greater than the former because it differs only in the quantity ΔW, which is added to both numerator and denominator of the fraction thereby increasing its magnitude.

ANNUAL MEETING

June 23–27, 1952

Dartmouth College **Hanover, N.H.**

Report of Treasurer, 1950-1951

Ernest C. Davies
Certified Public Accountant

Evanston, Illinois
November 8, 1951

Mr. C. L. Skelley
Technical Book Department
The Macmillan Company
60 Fifth Avenue
New York 11, New York

Dear Mr. Skelley:

In accordance with your instructions we have examined the accounts and records of the American Society for Engineering Education for the year ending June 30, 1951 and submit herewith the following statements prepared therefrom:

Exhibit I—Comparative Balance Sheets
Exhibit II—Comparative Statements of Changes in Funds
Exhibit III—Comparative Statements of Income and Expense
Exhibit IV—Comparative Statements of Receipts and Disbursements
Notes to Financial Statements

In connection with the statements as of June 30, 1951, we examined and tested the accounting records, traced the receipts as recorded to deposit, checked the disbursements, counted the securities on hand, and secured direct confirmation for all funds or securities in the hands of outside parties. Our examination was made in accordance with generally accepted auditing standards and included all procedures which we considered necessary in the circumstances.

In accordance with a resolution by the Board of Directors, Furniture and Fixtures account was written down to a nominal value of $1.00 and all subsequent purchases are to be expensed.

Additional expense accounts have been added to the Statement of Income and Expense for 1951 in order to further classify the expense for the year. It is to be noted that, although some of these accounts represent expenses and incurred in prior years, others are merely a reclassification of expenses existing in 1950. Therefore, although the latter expenses were provided for in the budget, no comparison of actual and budget expenses can be made.

In our opinion these statements fairly present the position of the Society at June 30, 1951 and the results of its operation for the period then ended.

Yours truly,
ERNEST C. DAVIES
Certified Public Accountant

AMERICAN SOCIETY FOR ENGINEERING EDUCATION
COMPARATIVE BALANCE SHEETS

	June 30, 1950	June 30, 1951
Assets		
Current Fund:		
Cash in State Bank and Trust Company	$26,280.79	$21,391.53
Petty Cash Fund	300.00	300.00
U. S. Government Bonds—Series G	30,700.00	30,700.00
	$57,280.79	$52,391.53

Life Membership Fund:		
Cash	$ 155.87	$ 183.11
U. S. Government Bonds—Series G	1,000.00	1,000.00
	$ 1,155.87	$ 1,183.11
B. J. Lamme Fund:		
Cash—Checking	$ 276.93	$ 230.46
Principal Cash in Hands of Trustee	9.00	9.00
Securities and Mortgages	5,132.73	5,132.73
	$ 5,418.66	$ 5,372.19
Accounts Receivable:		
Advertising	$ 2,503.85	$ 1,560.90
Less—Reserve for Bad Debts	315.00	——
	$ 2,188.85	$ 1,560.90
Dues	1,400.00	1,275.00
Brochures	631.20	——
Westinghouse Educational Foundation	209.73	83.91
Income Cash in Hands of B. J. Lamme Fund Trustee	121.44	121.46
	$ 4,551.22	$ 3,041.27
Inventory	$ 1.00	$ 1.00
Furniture and Fixtures (See notes to financial statements)	748.78	1.00
Total Assets	$69,156.32	$61,990.10
Liabilities and Capital		
Current Liabilities:		
Accounts Payable—Publications	$ 2,110.54	$ 16.65
Other Accruals	371.87	1,453.54
	$ 2,482.41	$ 1,470.19
Prepaid Membership Dues	$ 1,195.20	$ 1,706.78
Funds:		
Life Membership Fund	$ 1,155.87	$ 1,183.11
B. J. Lamme Fund	5,418.66	5,372.19
General Education Board	9,950.00	——
Teaching Aids Fund	——	4,362.50
	$16,524.53	$10,917.80
General Fund:		
Reserve for ECRC	$ 1,315.03	$ ——
Reserve for Special Projects	7,543.07	6,056.62
Unappropriated Surplus	40,096.08	41,838.71
	$48,954.18	$47,895.33
Total Liabilities and Net Worth	$69,156.32	$61,990.10

COMPARATIVE STATEMENT OF CHANGES IN FUNDS

	12 Months Ended June 30, 1950	12 Months Ended June 30, 1951
Life Membership Fund		
Balance at Beginning of Period	$ 1,129.70	$ 1,155.87
Add: Contribution to Fund	25.00	25.00
Interest on Fund	1.17	2.24
Balance at End of Period	$ 1,155.87	$ 1,183.11
B. J. Lamme Fund		
Balance at Beginning of Period	$ 5,477.62	$ 5,418.66
Add: Contribution to Fund	118.04	126.04
	$ 5,595.66	$ 5,544.70
Less: Award	177.00	172.51
Balance at End of Period	$ 5,418.66	$ 5,372.19
General Education Board		
Balance at Beginning of Period	$14,950.00	$ 9,950.00
Add: Refund Received from SE Section	——	3,279.02
	$14,950.00	$13,229.02
Less: Charges during the Period	5,000.00	——
Refund Made to General Education Board	——	13,229.02
Balance at End of Period	$ 9,950.00	——
Teaching Aids Fund		
Balance at Beginning of Period		——
Add: Income of Fund		$ 4,570.00
Less: Expenses of Fund		207.50
Balance at End of Period		$ 4,362.50
Balance at Beginning of Period	$41,411.11	$40,096.08
Add: Excess Income over Expense	7,543.07	——
Excess Expense over Income (See Notes to Financial Statement)	($311.07)	——
Transfer from ECRC Reserve	1,315.03	——
Transfer from Special Projects Reserve	1,486.45	2,490.41
	$48,954.18	$42,586.49
Less: Restriction of Surplus for ECRC Reserve	$ 1,315.03	——
Restriction of Surplus for Special Projects Reserve	7,543.07	——
Write off of Furniture and Fixtures	——	747.78
	$ 8.858.10	$ 747.78
Balance at End of Period	$40,096.08	$41,838.71

COMPARATIVE STATEMENT OF INCOME AND EXPENSE

	12 Months Ended June 30, 1950	12 Months Ended June 30, 1951	Budget 1951-52
Income:			
Current Dues—Individual	$38,468.18	$39,113.20	$39,000
Institutional	7,010.00	6,661.00	6,700
Sale of Publications	3,341.30	2,257.24	1,900
Advertising	10,045.16	9,401.38	9,100
Interest on Government Bonds	667.50	792.50	780
ECRC	1,031.75	1,228.06	—
Income—B. J. Lamme Fund	10.73	.02	—
Miscellaneous	39.22	863.62	—
Total Income	$60,613.84	$60,317.02	$57,480
Expense:			
Cost of Publications	$23,632.60	$24,139.43	$25,000
Salary of Secretary	5,500.00	5,500.00	5,500
Salary of Office Secretaries	2,070.00	4,970.00	5,640
Clerical Salaries	3,352.10	548.44	700
Retirement Emeritus	1,360.00	1,360.00	1,360
Travel-Secretary's Office	989.94	1,007.73	950
Postage, Telephone and Telegraph	1,595.50	1,416.98	1,600
Supplies, Expense, Sundry Prtg.	2,052.68	2,895.55	2,700
Dues—Am. Council on Education	100.00	100.00	100
Contribution ECPD	500.00	500.00	500
Officers Traveling Expense	1,510.91	1,694.64	2,000
Annual Meeting Expense	2,737.84	2,016.53	2,700
Expenses ECAC	733.44	1,630.66	2,200
Expenses ECRC	4,334.18	8,379.54	4,350
Committees and Conferences	609.95	1,153.57	1,300
President's Expense	—	460.87	500
Bonding, Auditor's and Other Society Fees	—	486.28	325
Office Expense	—	80.27	—
Miscellaneous	—	75.31	—
Special Projects Expense	1,991.63	—	—
Purchase of Typewriters	—	291.45	—
N.Y. Times Reprint	—	615.71	—
Committee on Improvement in Teaching	—	397.42	—
Contribution EJC	—	407.71	—
Additional Contribution ECPD	—	500.00	—
Total Expense	$53,070.77	$60,628.09	$57,425
Excess of Income over Expense	$ 7,543.07		
Excess of Expense over Income		$ 311.07	
Transfer from reserves to cover ECRC loss (see notes to statements)		$ 2,801.48	
Balance to Surplus		$ 2,490.41	

COMPARATIVE STATEMENT OF RECEIPTS AND DISBURSEMENTS

Budget 1951-52		12 Months Ended June 30, 1950	12 Months Ended June 30, 1951
$39,000	Balance at Beginning of Period	$39,201.86	$26,280.79
	Receipts:		
6,700	Current Dues—Individual	$35,435.18	$36,600.00
1,900	Institutional	7,010.00	6,586.00
9,100	Back Dues	1,733.25	1,518.00
780	Dues in Advance	1,195.20	1,706.78
——	Sale of Publications	2,710.10	2,888.44
——	Advertising	9,396.31	10,029.33
——	Interest on Bonds	667.50	792.50
$57,480	ECRC	1,031.75	1,228.06
$25,000	Westinghouse Educational Foundation	222.29	250.00
5,500	Lamme Fund Income	——	——
5,640	Refund from SE Section to Close Fund	——	3,279.02
700	Teaching Aids Income	——	4,570.00
1,360	Miscellaneous	39.22	863.62
950			
1,600	Total Receipts	$59,440.80	$70,311.75
2,700	Disbursements:		
100	Cost of Publications	$23,122.06	$26,233.32
500	Administrative Salaries	10,922.10	11,018.44
2,000	Retirement Emeritus	1,360.00	1,360.00
2,700	Travel—Secretary's Office	989.94	1,007.73
2,200	Postage, Telephone and Telegraph	1,656,67	1,325.32
4,350	Supplies and Sundry Printing	2,052.68	2,809.05
1,300	Dues—American Council on Education	100.00	100.00
500	Contribution ECPD	500.00	500.00
325	Officers Traveling Expense	1,510.91	1,644.04
——	Annual Meeting Expense	2,422.36	1,491.35
——	Expenses ECAC	733.44	1,618.13
——	Expenses ECRC	4,334.18	8,038.37
——	Committees and Conferences	598.25	1,132.79
——	Westinghouse Award	322.44	124.18
——	Expense—Carnegie Survey	4,745.21	——
——	Award—General Education Board	5,000.00	——
——	Purchase of Government Bonds	10,000.00	——
$57,425	President's Expense	——	442.62
	Teaching Aids	——	207.50
	Bonding, Auditor's and Other Society Fees	——	486.28
	Office Expense	——	80.27
	Miscellaneous	——	75.31
	Special Projects		
	Purchase of Typewriters	——	356.45
	NY Times Reprint	——	615.71
	Committee on Improvement of Teaching	1,991.63	397.42
	Contribution EJC	——	407.71
	Additional Contribution ECPD	——	500.00
	Refund to General Education Board	——	13,229.02
	Total Disbursements	$72,361.87	$75,201.01
	Balance at End of Period	$26,280.79	$21,391.53

AMERICAN SOCIETY FOR ENGINEERING EDUCATION
NOTES TO FINANCIAL STATEMENTS

By resolution of the Board of Directors furniture and fixtures were written down to a nominal value, and in conformity with this policy new typewriters purchased were charged against the current year's operations.

It was further resolved by the Board of Directors that a transfer should be made from the appropriated surplus to provide for the excess of ECRC expenses over the sum of ECRC income and the expenditures allowed by the Society budget. The computation of the transfer was made as follows:

ECRC Income	$1,228.06	
Budgeted Expenditures	4,350.00	
	$5,578.06	
ECRC Expense	8,379.54	
Net Loss		$2,801.48
To be provided for:		
By transfer from ECRC Reserve	$1,315.03	
By transfer from Special Project Reserve	1,486.45	
		$2,801.48

ECRC expenses exceeded anticipations as a result of heavy publication costs. ECRC would not have operated at a loss if the inventory of the unsold publications had been carried on the balance sheet. (This inventory was approximately $3000 at cost on balance sheet date.) However, in conformity with Society policy of carrying only the most liquid assets on the balance sheet, the inventory of unsold publications was excluded, and the above policy was adopted.

Respectfully submitted,

CHARLES L. SKELLEY,
Treasurer

Mid-Winter Meetings

The Cooperative Division of the ASEE held its third Annual Mid-Winter meeting at Northwestern University, November 8, 9, and 10. The program was planned to be a part of the Technological Institute's program in the Centennial celebration of Northwestern University this year.

A conference of the Division of Relations With Industry will be held at the Massachusetts Institute of Technology on February 2, 1952. The theme of the conference will be "The Student as an Individual." A meeting of the Advisory Committee of the Division will be held on Friday, February 1, 1952, at 9:30 A.M. The first draft of the papers to be presented at the June meeting will be discussed.

The Mid-Winter meeting of the Engineering Drawing Division will be held at three New York universities—The Cooper Union, U. S. Military Academy at West Point, and Columbia University on January 23, 24 and 25, 1952. The complete program was published in the November issue of the JOURNAL OF ENGINEERING EDUCATION.

THE T-SQUARE PAGE

Officers
C. H. SPRINGER, *Chairman*
R. T. NORTHRUP
T. T. AAKHUS
C. J. VIERCK
J. S. RISING
H. E. GRANT
R. S. PAFFENBARGER

DEVOTED TO THE INTERESTS OF ENGINEERING DRAWING

B. L. WELLMAN, *Editor*
Worcester Polytechnic Institute

Officers
J. GERARDI
J. G. MCGUIRE
W. E. STREET
C. E. ROWE
H. C. SPENCER
W. J. LUZADDER

What Happened at East Lansing?

For six very busy days 177 engineers and teachers talked and listened, debated and relaxed, in the lecture room of Olds Hall and in the luxurious lounges of Shaw Hall. The subject was engineering drawing, the time was June, and the place was the beautiful campus of Michigan State College. With such a matchless combination it is not surprising that the third Summer School for Teachers of Engineering Drawing was a complete success.

Our gracious host provided comfortable rooms and excellent meals in their new and very modern Shaw Residence Hall, while the weather man very reasonably insisted upon only one rainy day. The sessions in Olds Hall were intensive and stimulating, and were conducted with engineering precision. Sunday conveniently interrupted the sessions to allow members to drive to Detroit, Greenfield Village and Edison Institute, or to just relax and talk more shop.

The theme of the Summer School was: Improving Our Status as Engineering Drawing Teachers. A complete list of the papers to be presented was published in the May, 1951, issue of the Journal of Engineering Drawing. Space does not permit a discussion of each of the 23 papers presented at the meeting, nor of the many questions and comments that buffeted the panels of "experts" (a term they all modestly rejected) at the end of each session. Needless to say, the panel members acquitted themselves admirably, and their comments and summations contributed much of value to the sessions. It was the concensus of many members that these panel discussions ought to be continued at future meetings.

It was the observation of your editor that the questions most frequently asked and discussed were: 1) is there an increasing pressure to further reduce the time allotted to drawing? 2) are integrated drawing courses pedagogically sound and more efficient of time? 3) how can we convince the administrations that descriptive geometry is a vital part of an engineer's education? 4) what kind of visual aids can best be adapted to the teaching of drawing? 5) what can we do to promote more work in advanced graphics? 6) is the master bow professional type set the best for student use? 7) what to do with students who have had drawing in high school?

Although the above topics were very popular and much debated, the solutions proposed were many and varied. Much more remains to be said, and your editor will welcome and publish on this page any further discussion. Take any side of the issue, but write it down and send it in. One man's opinion often proves to be the right one.

At the Annual Business Meeting the results of the election were announced and the newly elected officers for the coming

year are:

Chairman: C. H. Springer
Secretary: R. T. Northrup
Member Ex. Com.: J. S. Rising
Ed. T-Square Page: B. L. Wellman
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The amendment to the Articles of Procedure to create the new office of Vice-chairman was unanimously adopted by the membership. This amendment was announced in the May issue of the *Journal of Engineering Drawing*. Following the adoption, Dean Jasper Gerardi was nominated and elected to the new office.

Chairman-elect Springer then announced that "in view of the great concern felt by members of the Drawing Division about the continued and progressive squeeze being placed on all drawing departments for time, that the Policy Committee of the division has been instructed to formulate a policy that could be implemented by the entire division to combat this tendency."

Chairman Paffenbarger reported that the Mid-Winter Meeting will be held in New York on January 23, 24 and 25, 1952. The program for this meeting will be announced on this page in an early issue. It was also announced that the Mid-Winter Meeting for 1953 will be held at the University of Nebraska at Lincoln, Nebraska.

Summer Schools

The Executive Board of the ASEE has authorized sponsorship of summer schools proposed by the Electrical Engineering Division and the English Division. Both summer schools will be held at Dartmouth preceding the Annual Meeting. A summer school on Sanitary Engineering has been proposed by the Civil Engineering Division.

The General Electric Company has proposed a summer school program on methods of instruction which would familiarize educators with some of the novel methods of instruction used in the GE Company's post-graduate program. The Executive Board authorized ASEE endorsement of this summer school program.

New Members

BACH, GEORGE L., Dean, Graduate School of Industrial Administration, Carnegie Institute of Technology, Pittsburgh, Pa. W. N. Jones, R. B. Teare.

BARTHOLOMEW, EDWARD L., JR., Associate Professor of Mechanical Engineering, University of Connecticut, Storrs, Conn. C. H. Coogan, Jr., F. L. Castleman, Jr.

BOWMAN, LEE, Head, Architectural and Photographic Depts., Franklin Technical Institute, Boston, Mass. B. K. Thorogood, R. G. Adams.

CARPENTER, HOWARD J., Assistant Professor of Mechanical Engineering, University of Vermont, Burlington, Vt. A. F. Tuthill, J. A. Bullard.

CASEMAN, AUSTIN B., Instructor in Civil Engineering, State College of Washington, Pullman, Wash. E. G. Ericson, L. B. Almy.

CRIM, ELMER B., Director, Co-operative Education, Stetson University, LeLand, Fla. S. C. Hollister, A. B. Bronwell.

DECKER, J. J., Office Manager, Advertising and Sales Prom., American Radiator and Standard Sanitary Corp., Pittsburgh, Pa. G. D. Lobingier, G. L. Scott.

DUCHACEK, HOWARD, Assistant Professor of Mechanical Engineering, University of Vermont, Burlington, Vt. A. F. Tuthill, J. A. Bullard.

FLICK, CARL, JR., Research Fellow, Microwave Research Institute, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. C. C. Whipple, J. W. Hostetter.

GOEHRING, HENRY G., Placement Director, College of Engineering, University of Wisconsin, Madison, Wis. R. A. Ragatz, M. O. Withey.

GREENE, JAMES H., Assistant Professor of Industrial Engineering, Purdue University, Lafayette, Indiana. R. W. Lindley, O. D. Lascoe.

HAMMOND, ALEXANDER F., Instructor in Drawing and Designing, Clemson College, Clemson, S. C. J. E. Shigley, S. R. Rhodes.

HEINLEIN, DAVID M., Head, Science Dept., Rutgers Preparatory School, New Brunswick, N. J. E. C. Easton, M. T. Ayers.

HUDELSON, GEORGE D., Assistant Professor of Mechanical Engineering, Ohio State University, Columbus, Ohio. S. R. Beitler, A. I. Brown.

JENKS, JOHN F., Assistant Professor, Technical Extension Division, Purdue University, Indianapolis, Ind. E. C. Susat, A. W. Collins.

JONES, THOMAS F., JR., Assistant Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. C. E. Tucker, K. L. Wildes.

KAUZLARICH, JAMES, Assistant, Graphics Dept., Columbia University, New York, N. Y. A. P. Boehmer, A. B. Cambel.

LESLIE, PHILIP, Assistant in Chemistry Library, University of Illinois, Urbana, Ill. W. C. Huntington, S. H. Pierce.

LUKER, JAMES A., Assistant Professor of Chemical Engineering, University of Denver, Denver, Colo. D. C. Davis, Jr., T. O. Reyhner.

MAECHLER, HUGO C., Assistant Professor of Drawing, University of Wisconsin Extension, Milwaukee, Wis. J. G. Van Vleet, W. M. Christman, Jr.

MARSHALL, GILBERT A., Instructor in Mechanical Engineering, University of Vermont, Burlington, Vt. A. F. Tuthill, E. R. McKee.

MASON, MARTIN A., Dean of Engineering, George Washington University, Washington, D. C. C. H. Walther, J. S. Antel.

MATCHETT, GERALD J., Associate Professor of Business and Economics, Illinois Institute of Technology, Chicago, Ill. P. Davis, E. R. Whitehead.

MCAMIS, J. C., JR., Assistant Professor of Mechanical Engineering, University of Tennessee, Knoxville, Tenn. R. C. Robertson, J. D. Maloney.

McCORMICK, JAMES P., Assistant Professor of Electrical Engineering, Clarkson College of Technology, Potsdam, N. Y. R. A. Record, A. R. Powers.

McDOWELL, ELMER H., Instructor in Industrial Drafting, Kansas Technical Institute, Topeka, Kans. G. R. Cotton, H. L. Livas.

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MONTGOMERY, SIGMUND J., Associate in Industrial Engineering, Columbia University, New York, N. Y. S. C. Hollister, A. B. Bronwell.

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OXFORD, CHARLES W., Assistant Professor of Chemical Engineering, University of Arkansas, Fayetteville, Ark. W. B. Stiles, N. H. Barnette.

REED, GEORGE W., Assistant Professor of Electrical Engineering, Clarkson College of Technology, Potsdam, N. Y. A. R. Powers, A. B. Bronwell.

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SMITH, CLYDE P., Instructor of Manufacturing Processes, General Engineering Dept., Purdue University, Lafayette, Ind. O. D. Lascoe, H. A. Bolz.

SMITH, GUSTAVUS E., Assistant Professor of Electrical Engineering, University of Kentucky, Lexington, Ky. D. V. Terrell, A. B. Bronwell.

STREET, DONALD T., Associate Professor of Engineering, University of Rochester, Rochester, N. Y. R. F. Eisenberg, C. L. Rickard.

TATE, VERNON D., Director of Libraries, Massachusetts Institute of Technology, Cambridge, Mass. S. C. Hollister, A. B. Bronwell.

WEINBERG, PHILIP, Instructor in Electrical Engineering, University of New Mexico, Albuquerque, N. M. W. G. Hoover, M. E. Van Valkenburg.

WELLINGTON, CHARLES B., Extension Lecturer in Mechanical Engineering, University of New Hampshire, Durham, N. H. E. H. Stolworthy, E. T. Donovan.

WENDT, ROBERT H., Vice-President and General Manager, Globe Corporation, Aircraft Division, Lockport, Ill. K. L. Burroughs, A. Stott.

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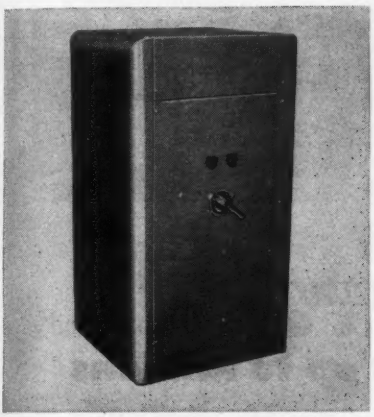

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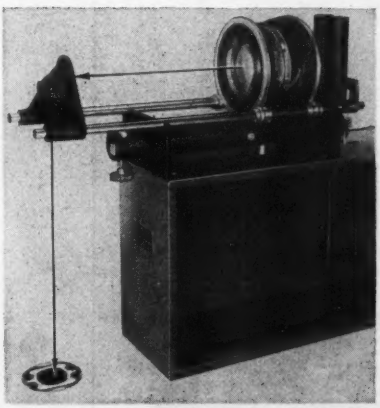

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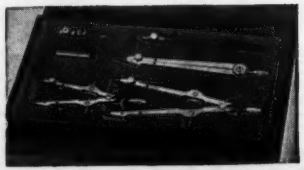

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